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AGRICULTURAL JOURNAL

ISSUED BY THE

DEPARTMENT OF AGRICULTURE, FIJI.

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EDITORIAL.

THIS number of the *Agricultural Journal* completes the issues for the year 1932. It contains records of the meetings of the Agricultural Convention, of the trial shipments of bananas to Vancouver, and of the copra drier erected for investigational purposes by the Coconut Committee. The "Review of Agricultural Industry in Fiji" adopted as the subject for the public meeting of the Convention gave rise to some interesting disclosures regarding the dairying industry, while the need for establishing a meat export industry to provide an outlet for surplus cattle was again emphasized. The handicap of indirect exporting channels for butter seems likely to be removed, at any rate to some extent, as the first shipment of Fiji butter with through loading to the United Kingdom has been arranged to take place in December when the three factories acting in co-operation have guaranteed a shipment of 450 boxes. The saving in comparison with the former system of shipping to Auckland and thence transhipping to the United Kingdom will amount to about 5s. per cwt. of butter.

In his paper read before the Agricultural Convention Mr. Simmonds called the attention of graziers and others to the necessity of replacing the areas of *Clidemia hirta* with useful growth instead of allowing other weeds to occupy these lands. To that end different procedures suggest themselves under different conditions. The great objective is to obtain a sward of good grasses or legumes. Where the area is fairly free from objectionable weeds, and such plants as para grass, sensitive (*Mimosa pudica*), and *Micania scandens* (mile-a-minute) abound, the indications are that if cattle are excluded from the area these plants will over-run the thrips-weakened weed and smother it out. In fairly open paddocks it should pay to cut or pull the weed out, relying upon the thrips to prevent re-infestation. Where other weeds, however, are abundant, efforts should be made to prevent these replacing the curse. Ploughing and sowing with a good grass or cover crop, or using the land for arable purposes for one or two crops to clear out the weeds would be good methods. In some cases, too, sowing with a leguminous crop should help to smother the weed. What is important is to keep the land covered and to replace the weed with useful growth.

Further inquiry into the reported presence of citrus canker in Fiji has clearly demonstrated that the disease is not present in the Colony. Hitherto, the export of mandarins to Australia has not been possible because of the inability of the Inspector of Produce to certify that the fruit had been produced in a locality free from citrus canker. Such a certificate of freedom from the disease can now be given, and exports to Australia are again possible. With three certain markets—Vancouver, Auckland and Sydney—there are excellent prospects of developing the citrus industry in Fiji.

CONVENTION OF AGRICULTURAL ASSOCIATIONS OF FIJI.

PRESIDENT'S ADDRESS TO DELEGATES TO THE CONVENTION.

The present occasion sees the end of the first year of life of the Convention of Agricultural Associations of Fiji. This body is not the first of its kind, for Fiji has from time to time had many Associations formed for the advancement of the interests of agriculturists, particularly the European section. Prior to the Cession such an Association was formed in Levuka, but how long it lasted or what it did I have been unable to find out. In pre-war days a powerful Planters' Association carried on very useful work for many years and during more recent years district Progress Associations have been formed, while several bodies, having for their object the advancement of interests of particular industries, are centred in Suva. Dr. J. D. Tothill endeavoured to unite the various Associations then existing into one body, but it was not until last year that the final difficulties were overcome and the present Convention formed.

2. The success of an institution such as this depends almost entirely upon the attitude of the member Associations to the central body, and upon the existence of confidence and good feeling amongst the individual Associations, who thus form that central body. The year just closed has been one of great difficulty for all engaged in agricultural pursuits as well as for those business people, who are themselves dependent upon the free movement of the Colony's produce and upon good prices in the world's markets. The year, therefore, has been largely one of re-construction following the heavy storms of the past two years and of adaptation to a new state of conditions occasioned by a world-wide drop in market prices of all commodities produced in Fiji. For these reasons the participating Associations have perhaps not made the use of the central body that they would have done under more normal times, and so the Convention has not been so actively engaged in forwarding the interests of its member Associations as I anticipated when it was formed.

3. Although but two meetings of the Executive Committee have been held during the year, a number of matters of direct interest to all the participating Associations have been dealt with. Among the more important of these were:—Freight rates on Fiji produce; trial shipments of bananas and other fruit to Vancouver; the establishment of a meat export industry; improvements in methods of marketing citrus fruits; the marketing of hides in New Zealand; the marketing of mandarins in Australia; inquiries regarding the conditioning, drying and marketing of maize; and the preparation and marketing of cassava starch.

4. The participation of Fiji in the Auckland and Ottawa Exhibitions, though not directly arranged under the auspices of the Convention, is, nevertheless, a matter of direct interest to all Associations, as thereby the Colony and its products have been widely advertised.

5. Many of these matters were taken up primarily by me in my capacity as Director of Agriculture, but in several cases members of the Convention were consulted.

6. *Freight rates on Fiji produce.*—The freight on Fiji bananas was reduced 10 per cent. by the Union Steam Ship Company Limited in February, 1932, following the strong representations by the Fiji Planters' Association, individual shippers and the Department of Agriculture. The rate is now 3s. 7d. per case which is still regarded as too high and it is hoped that it may be possible to secure further reduction. The Union Steam Ship Company Limited have also undertaken to carry maize and peanuts at reduced rates both to New Zealand and to Vancouver, but before these commodities can be exported in quantity, conditioning and drying facilities must be provided. Closely related to this subject is the question of export of butter from the Colony by direct shipments, instead of *via* New Zealand, with the consequent additional freight and transhipment charges. Negotiations are in progress for the shipment of butter by direct steamers giving a through loading from Suva to the United Kingdom.

7. *Trial shipments of bananas and other fruits to Vancouver.*—Glutting of the New Zealand market with bananas and the low prices prevailing there since the beginning of 1932 made it desirable to explore the possibilities of profitable export of this fruit to other consuming centres. Five trial shipments of bananas have been sent to Vancouver and the conditions under which fruit must be harvested, transported, handled and shipped for profitable disposal in Western Canada have been ascertained. These trials will be the subject of a Departmental report to be issued shortly.* Small consignments of mandarins and fresh pineapples have also been shipped to Canada. Reports from distributors indicate that with careful handling and packing in Fiji there are limited prospects for the profitable disposal of such fruit in Vancouver.

8. *Establishment of a meat export industry.*—This question has been widely discussed both at Agricultural Conferences and by the Convention. The Executive Committee appointed a sub-committee consisting of Mr. E. Duncan and myself with power to co-opt Mr. C. R. Turbet for the purpose of preparing a definite scheme. Mr. Turbet's recommendations will be placed before the Convention. It must, I think, be realised that the establishment of abattoirs and cold storage is a matter for private enterprise which will, it is hoped, become sufficiently interested before long. The profitable disposal of cattle is very closely related to the cheap and effective maintenance of coconut plantations as well as being of primary interest to all stockmen in the Colony.

9. *Improvements in the method of marketing citrus fruits.*—It has for some time been realised that Fiji mandarins and oranges were in danger of losing their place in the New Zealand market. Close inquiry was pursued by the Department of Agriculture for some time and experiments conducted during the 1931 season have already been reported in the *Agricultural Journal.* The lessons learned from those trials were applied to all exports of oranges and mandarins during the 1932 season. The provision of a fly-proof shed on the Suva wharf, alterations to the fumigating chambers and the co-operation of shippers with the Agricultural Department made it possible to improve the quality and appearance of the fruit exported to a standard never hitherto attained. The higher prices and favourable comments of importers demonstrated the advantages of the better methods practised. It is hoped that

* See Page 74.

growers and shippers will take full advantage of the improved market prospects during the coming season.

10. *Marketing of hides in New Zealand.*—The New Zealand Government has hitherto prohibited the importation of salted hides from Fiji. Representations have been made by the Fiji Government requesting that the prohibition may be removed. The matter is not yet concluded.

11. *Marketing of mandarins in Australia.*—A few years ago the presence of citrus canker was reported and resulted in an embargo being placed by Australia against the importation of mandarins from Fiji. It has recently been demonstrated that the diagnosis of the disease was quite wrong and steps have been taken to bring the true facts to the notice of the Federal Government with the object of securing the admission of Fiji mandarins to the Sydney market where opportunities for profitable disposal of this fruit occur before the Australian crop of oranges is ready for marketing.

12. *Inquiries regarding conditioning, drying and marketing of maize.*—This subject is of general interest to the Colony and of particular importance in connection with Fijian and Indian agriculture. Maize grows well in many districts of the Colony and forms an important item of several suitable systems of crop rotation which include other marketable crops. Crop rotation is essential to the conservation of soil fertility and if the system adopted in any district can include a high proportion of marketable crops it is more likely to be generally adopted. The Sigatoka Progress Association has requested that the Convention will consider the establishment of a maize drying and conditioning plant at Suva. The inquiries which have already been made render it possible to give details of the equipment necessary. The subject has been carefully discussed with the Managing Director of Henry Simon (Australasia) Limited who visited Suva recently. This firm is widely known in connection with the wheat industry and manufactures plant suitable for the drying and conditioning of various kinds of grain, including maize. Opportunities for the profitable disposal of maize exist in New Zealand, but until consignments can be standardised and certified in quality there is little prospect of building up a successful export business.

13. *Preparation and marketing of cassava starch.*—It has been suggested that the utilisation of tapioca for starch making in Fiji might be a profitable industry for Fijians. The Director of the Imperial Institute who has been asked to advise on the subject states that no complete installation of British manufacture for the making of cassava starch is obtainable. Moreover, firms consulted stated that it is doubtful whether Fiji can compete in price and quality with countries already supplying what little quantities are required. The Director concludes " in the circumstances it would appear that the present is not a promising time for starting a cassava starch industry in Fiji."

14. All member Associations have from time to time been informed of the progress in regard to the more important subjects under consideration and in a letter dated 5th July, 1932, an outline of some of the things which had been accomplished and others which were being investigated was given.

15. In conclusion I desire to thank the members of the Executive Committee and the officers of participating Associations for many courtesies during the year, and I trust that the sphere of usefulness of the Convention may extend in future and that it may exert a favourable influence upon the interests of the Colony as a whole and in particular on those Associations intimately connected with it.

PUBLIC MEETING HELD IN THE TOWN HALL, SUVA, ON 11TH OCTOBER, 1932.

PARTICIPATING ASSOCIATIONS.

The Buca Bay Progress Association.
The Coconut Planters' Union Limited.
The Fawn Harbour Progress Association.
The Fiji Planters' Association.
The Fiji Show Association.
The Savusavu West Progress Association.
The Sigatoka Progress Association.
The Vanualevu Progress Association.

AGENDA.

1. OPENING ADDRESS.. .. .. .. His Excellency the Governor.
2. INTRODUCTORY .. .. A. C. Barnes, Esq.

A REVIEW OF AGRICULTURAL INDUSTRY IN FIJI.

3. DAIRYING .. .. Sir J. M. Hedstrom, Kt.
4. COCONUTS AND COPRA .. .. .. Major C. B. Joske, M.C.
5. CATTLE .. .. Ed. Duncan, Esq.
6. FRUIT AND MINOR CROPS . .. .. A. C. Barnes, Esq.
7. WEEDS IN RELATION TO AGRICULTURE.. H. W. Simmonds, Esq.
8. DISCUSSION (if time permits).

INTRODUCTORY.

Mr. Barnes, in introducing His Excellency the Governor, said that on behalf of the Convention of Agricultural Associations of Fiji he wished to thank His Excellency for the sympathetic manner in which he had received from time to time representations from the participating Associations and from the central body. The time that His Excellency had so kindly given to the meeting this year was evidence of his continued interest in agricultural matters appertaining to the Colony. Mr. Barnes said that it was proposed to offer a number of short addresses to the meeting and if time permitted discussion would be invited at the close of the proceedings. He informed the gathering that the proceedings would take the form of a series of short lectures on the subject "A Review of Agricultural Industry in Fiji," and he thanked all those gentlemen who had prepared papers for the meeting.

His Excellency, in rising to open the meeting, said that he wished to draw particular attention to the title " Convention of Agricultural Associations of Fiji." This was not an agricultural conference but a convention of various Associations which operated in different parts of the Group. He regarded the work done by these Associations as of prime importance to the Colony. He had met most of them in person and had obtained valuable advice and assistance from them. He referred to the Sigatoka Progress Association which he had recently met and which had brought forward several matters of importance, and he wished to inform the delegates of that Association that the suggestions were definitely in train. His Excellency said that he had met the Savusavu Progress Association two years ago when many useful

points were discussed. He wished to emphasise that these Associations should get together, and the meeting which was held once a year was an excellent opportunity for country Associations to come to Suva and work up a constructive policy for carrying on the general business of the Colony, particularly agriculture. He said there was a tendency in Fiji for people to slack—to let some other person do the work. This was quite the wrong attitude. Another wrong idea prevalent was that Government should do everything. Government should not interfere in the industries of the Colony at all, but Government was always willing to advise and to assist in every way possible.

His Excellency then referred briefly to the Colonial Sugar Refining Company Limited. In consequence of the generosity of His Majesty's Imperial Government this Company was able to stabilise the price of sugar-cane for a period of five years and this in turn gave a similar stability to the whole Colony, as the sugar-producing community knew the price that would be paid for sugar-cane. Then came the question of markets and the publicity of the Colony. He asked the community to do all they could to help the Government in getting this publicity. In his Address to Legislative Council he mentioned the small effort made at Ottawa and the signal results that had accrued. The gentleman in charge of the Fiji stand at the Ottawa Exhibition had been highly praised by the business community there and his efforts had resulted in several inquiries being made for Fiji produce.

His Excellency then touched on the question of shipping fruit to Los Angeles by Matson ships and said that this was a step in the right direction and that it was the duty of the Convention to push these matters. He said there was an opening for our bananas in Vancouver also. The difficulty of successfully marketing bananas at present was not that the fruit was inferior in texture and quality, but that the rough handling in Fiji caused the fruit to become bruised. People who were used to buying clean fruit would not purchase bruised and marked fruit. This was a most important matter and he was glad to see the steps taken by the Agricultural Department to improve the quality and get up of fruit leaving the Colony. He referred briefly to the improved appearance of citrus fruits brought about by grading and wrapping.

His Excellency concluded by stating that the staff of the Agricultural Department deserved great praise for the amount of energy they had displayed in connection with attempts to improve the quality of products exported from the Colony and said he felt sure that along these lines lay the future prosperity of the Colony.

DAIRYING.

By Sir J. M. Hedstrom, Kt.

The Director of Agriculture has asked me to prepare this paper not because I have any practical knowledge of the subject but because I am financially interested in the largest dairy farm in the Colony and, therefore, have sources of information.

Opinions differ as to whether there is any prospect of the dairying industry becoming a solidly profitable proposition in this Colony. Experience so far has not been sufficient to justify anyone in expressing a very definite opinion on this question, but in my opinion the facts so far recorded are hopeful, and I personally believe that within a few years the dairying industry will be firmly established on a payable basis.

Up to the present the industry has been assisted and bolstered by an import tax of 4d. per lb. The normal revenue tax in former years was 1d. per lb, so that the actual protection accorded has been 3d. per lb, but the whole of this has not been imposed on the consumer. By arrangement between the factories the wholesale price of locally-manufactured butter has been kept slightly below the landed cost of New Zealand butter, so that it would be fair to say that the local consumer has had to pay 2½d. per lb extra for his butter to help support the local industry.

The Agricultural Department estimates the amount of butter produced in the three factories and consumed locally during 1932 at 300,000 lb; a tax of 2½d. per lb on this would mean about £3,125—and that is the price which the public has had to pay in an endeavour to establish the new industry.

As to whether this contribution has been worth while must be judged by the following figures which have been kindly supplied to me by the Agricultural Department. According to these records the approximate area of pasture land used in connection with the manufacture of butter at the three factories is 8,000 acres. The number of families engaged in commercial dairying, excluding those supplying milk for human consumption, is recorded as follows:—Tailevu, 22; Rewa, 20; Navua, 10; total, 52; and the total number of persons maintained by dairying is stated to be:—

Tailevu . .	farmers	68	labour	90
Navua	,,	32	,,	150
Rewa	,,	46	,,	100
		146		340

The Agricultural Department estimates the capital invested in this industry is as follows:—

Live stock	£30,000
Farm buildings and equipment . .	15,000
Factory buildings, Machinery, &c. . .	13,000

This does not take into consideration the capital value of the land occupied by dairy farms but, in any case, this appears to me to be a very conservative estimate because the Fiji Pastoral Company Limited which, on its own farms, produces rather more than 25 per cent. of the total butter-fat produced in the Colony, has over £40,000 invested in the industry which figure, of course, includes the value of the freeholds owned by the Company.

The progress of the industry has been reasonably satisfactory although during the last two or three years that progress has been checked by abnormal conditions—floods in the Rewa and Navua districts resulting in heavy mortality. Still, the position is as follows:—In 1921 we imported 137,688 lb butter, valued at £13,887. In 1932, according to the official estimate, the three butter factories will supply all local demands and will export 250,000 lb butter, valued at about £11,000. It is remarkable to note the increase in the local consumption of butter since the local factories commenced operations. According to official records in 1921, before the first factory was established, we imported 137,000 lb butter; and in 1932 the three factories will have sold 300,000 lb of locally-manufactured butter. The total production figures by the three factories are stated as follows:—

1923	59,209 lb
1927	295,677 ,,
1932	550,000 ,,

It may be asked why, with this steady increase in production, the industry is not yet strong enough to stand on its own feet and operate without a protective tariff. The explanation is that unfortunately we have three small

factories in three different districts and between them they are only producing about 250 tons of butter per annum. This means that the overhead cost and manufacturing charges are excessive and this condition of affairs can only be remedied by a substantial increase in production. My own opinion is that when one of the factories has reached an output of 200 tons per annum it will be on a good payable basis. This, of course, is only a wild guess—so much depends on the price of butter in the London market. According to official records in 1927 the Colony exported 54,208 lb butter which realised an average price of 1s. 5d. per lb, and in 1932 the export is estimated at 250,000 lb and the average price realised is estimated at 10½d. per lb. If the price realised on export butter should increase to 1s. 2d. per lb f.o.b. Suva, the industry would immediately become profitable both to farmer and factory owner.

It is interesting to study the prospects of increased production in the near future. The Agricultural Department records show the following as the total number of animals used in connection with the three factories:—Milking cows, 2,300; dry cows, 750; heifers, 1,200; bulls, 120; calves, 600; total, 4,970. The total number of cows is shown as 3,050 and the butter-fat production for 1932 at 458,000 lb. This means that after providing milk for the rearing of calves and for domestic use the butter-fat delivered at the factories averaged 150 lb per cow—an excellent result at this early stage in the history of the industry. The accurate records of the Fiji Pastoral Company Limited on their own farms bear out the official estimate. At the end of June, 1932, the Fiji Pastoral Company Limited had 774 cows (dry and in milk) on its eight farms and, during the twelve months ended 30th June, these farms delivered 125,587 lb of butter-fat to the factory—an average of 162 lb per cow—after providing for the feeding of calves and domestic consumption. The increase in production is dependent mainly on four factors:—

(1) An increase in the number of cows milked. From this cause alone the increase during the next two years should be fairly substantial. The estimated number of cows is 3,050; heifers are put down as 1,200, and calves as 600. We may reckon that at least two-thirds of the calves are heifer calves, that means 1,600 potential milk producers which should come into profit within the next two years. If we reckon the wastage of the adult cows at 20 per cent. for the two years that would reduce their number to 2,450, and if we reckon a wastage of 20 per cent. amongst the heifers and calves that would give us, at the end of two years, 3,700 milking cows, or an increase of nearly 25 per cent. These estimates are also born out by the very accurate returns kept by the Fiji Pastoral Company Limited. At the end of June, 1932, this Company had 774 adult cows and 507 heifers, or heifer calves. On the same basis of calculation this Company should have about 1,000 milking cows at the end of 1934, or an increase of about 30 per cent.

(2) The next factor is an increase in the average production. There can be little doubt that the average production is on the increase because most people engaged in this industry are endeavouring to improve their herds by buying good bulls, but this factor will not come into full effect until scientific herd-testing is more general throughout the dairy herds of the Colony. A friend sent me recently a cutting from an Australian paper on this subject which reads as follows:—

" Waster or High Producer ?—Only the Tester can tell.

" Only an actual test can determine the productive ability of a dairy cow. The truth of this is being continually proved, the disparity

between the owner's estimate of his animals' productivity and the fact as revealed by the Babcock tester being in some cases very considerable indeed. A personal instance, on the occasion of taking over a herd from its previous owner, was quoted by Mr. J. O'Meara, in the course of a paper read at the recent Cobargo Conference of the Agricultural Bureau:—

> 'The man in charge pointed out those he considered the best cows in the herd, and also pointed out several cows which he considered should be culled out for various reasons. At that time the herd had not been tested. Later on this herd (of 60 cows) was put under Government test, and it was remarkable that neither the owner of the herd, nor the man who worked there previously, nor myself, could have placed the first few cows in their proper order as producers. In fact, the cow we placed No. 1 should have been No. 44, and our No. 2 was nineteenth on the list; of the two cows which were pointed out by the previous tenant as the top of the herd, one was seventeenth from the top, and the other one, which was recommended as a show milker, was in fifty-seventh place.'

Such instances, pointed out the speaker, showed how useless it was to speak of a cow's ability except as proven by her test."

The Fiji Pastoral Company Limited, about two years ago, engaged the services of a qualified and experienced herd-tester and it is now just commencing to reap some benefit from his services. At present the standard is low—any cow producing less than 125 lb of butter-fat in a normal lactation period is eliminated. We intend soon to raise the standard and in about two years' time we may hope to have a herd in which the lowest producer will give us 150 lb of butter-fat in a normal lactation period. I am confident that it would be a very profitable investment if the producers of Rewa and Tailevy factories could combine and secure the services of a herd-tester.

(3) The third factor is an extension of the area under pasture. There is still room for considerable extension in this respect, but that is a factor which has its limits.

(4) Finally, the fourth factor is an improvement of pastures resulting in a greater carrying capacity per acre.

It is interesting to note the results achieved by different breeds of cows. In the North Island of New Zealand two breeds predominate—Jerseys and Friesians—and the battle still rages as to the respective merits of these breeds. I think we may say, speaking generally, that these two breeds predominate in Fiji dairy herds also. At Navua the two breeds are being tested out side by side.

At the end of June, 1932, the Fiji Pastoral Company Limited had 336 grade and pedigree Friesians, and 226 grade and pedigree Jersey cows, the Friesians being on four farms and the Jerseys on three farms and, in addition, had 212 so-called "local cows" on separate farms. These "local cows" are mainly the progeny of Jersey bulls and ordinary beef cows and have not developed sufficient Jersey characteristics to justify classing them with the grade Jerseys. After another two or three generations these "local cows" will be eliminated and replaced by grade Jerseys. The result of exact records has been to encourage the management to endeavour to increase the number of Jerseys and to limit the increase in the number of Freisians. On the farms carrying "local cows" only Jersey bulls are kept and as the local cows are gradually eliminated the number of grade Jerseys will be increased.

It is sometimes suggested that in a tropical country cows will not give a reasonable yield of butter-fat, but this theory is not substantiated by experience in Fiji. Records of the individual cows give some curious results:—

The largest producer for a single lactation period was 56-F (Jersey) which produced 485 lb, but the lactation period extended for 540 day. The cow appears to be quite normal and is in calf again.

Five Jerseys produced over 1 lb of butter-fat per day, extended over what might be termed a normal lactation period, and probably the best of these was Jersey 83–F with 372 lb in 300 days—very nearly 1¼ lb per day.

Only one Friesian is recorded as having produced over 1 lb butter-fat per day and that is D.T.F. with 314 lb in 307 days.

Curiously enough, this result is beaten by one "local cow," B–92–F, with 358 lb in 334 days.

Out of the Fiji Pastoral Company's 700 or 800 cows there are about 100 which produce over 300 lb butter-fat within the normal lactation period. According to our experience the locally-bred heifers (grade Jersey and grade Friesian) are at least equal to their imported grade Jersey or Friesian dams. A cow producing over 300 lb butter-fat on plain pasture with no artificial feeding would be considered a good cow anywhere.

In 1924 I visited one of the show dairy farms of Denmark where the poorest producing cow on the farm returned 400 lb butter-fat per annum, but that result was achieved by lavish and scientific feeding. Each cow received a balanced ration suited to her requirements and a separate ledger account was kept for each cow in which she was charged with the value of the food supplied and credited with the value of butter-fat produced.

The results so far achieved in Fiji lead one to cherish the hope that in seven or eight years' time there will be some dairy farms on which the average production per cow will be not less than 200 lb butter-fat per annum. When that average has been reached there will be no doubt as to dairying proving profitable in Fiji. Recently the Director of Agriculture stated that in his opinion dairying in Fiji would prove a profitable occupation to a reasonably hardworking European farmer with butter-fat at 1s. per lb. That is a conclusion with which I am in entire agreement.

Some people are opposed to the measure of protection extended to the dairying, but notwithstanding a good deal of money wasted and lost owing to inexperience and ignorance of local conditions I suggest that the figures indicate that the results have justified the measure of protection accorded to the industry. We have in use approximately 8,000 acres of land which would otherwise be jungle; the individuals directly engaged in the industry number about 500, and the actual value of the manufactured products, on the basis of the estimated output for 1932, is £34,500. This is the return the Colony receives for a tax of about £3,000 per annum on the consumers of butter. I do not believe the industry can yet stand without the present measure of support, but I think we may hope that in four or five years it may be possible to reduce the protection by 50 per cent. and still maintain the industry on a payable basis. This result will be accelerated if there is any substantial recovery in the price of butter on the London market.

COCONUTS AND COPRA.

By Major C. B. Joske, M.C.

Copra is one of the essential commodities of the world. About a million tons are imported yearly into Europe and the United States of America—roughly 750,000 tons to Europe and the balance to the States. World production is much greater because in many producing countries the copra is made into oil and used on the spot. As you all know, copra is crushed into coconut oil and copra cake in the rough proportions of two-thirds oil and one-third cake. Thus it can be stated that in the industrialised section of the world situated in the colder parts about 660,000 tons of coconut oil is produced from imported copra each year.

In addition, there is a large quantity of copra turned into coconut oil in the producing countries and shipped as coconut oil—about 200,000 tons yearly. The copra that is used in the international trade of the world may thus be estimated at something over 1¼ million tons per annum. Copra gives us a dual purpose oil—it forms the chief ingredient in the best soap in the world and it is in the top class for use as margarine. Coconut oil, therefore, plays a very definite part in the economic life of the world and to my mind that part is likely to increase. In fact, we can expect that the copra industry in this Colony will be still going strong when most other industries have declined and fallen. The copra production in Fiji bears the same relation to world production as 6d. does to one pound; but to the economic life of Fiji it bears a much greater relation.

Half the Copra in Fiji is produced by Europeans, and half by Fijians. The Europeans are mainly owner-planters, so that both races are Colonists in the true sense of the word, where entire lives and fortunes are wholly bound up with Fiji. One wonders sometimes whether the importance of copra to Fiji is sufficiently recognised. I suggest, therefore, it is opportune to consider means of improving and stimulating the copra industry of Fiji.

At the risk of boring you I propose to outline very briefly two ways in which this help can be afforded. The first is by the provision of long-term credit on cheap terms for responsible and solvent coconut planters. My suggestion in this respect at the Agricultural Convention in 1930 was backed by the coconut members and resulted in a committee being appointed. I have not seen its report, but my impression is that opinion was divided. I cannot help feeling that the non-coconut planting section of the committee was under the influence of the terribly low prices then prevailing for copra. Since then, England has gone off the gold standard, set her house in order and got her credit, as measured by the Bank of England rate, down from 6 per cent. to 2 per cent. Every English paper we read nowadays talks of the flood of idle money in London—even Fiji got a drop of it the other day in floating portion of our Colonial loan at 4 per cent. at £102. Is it too much to ask that the Government should act as the conduit pipe between cheap money in London and the coconut planters in Fiji?

It may be argued that the local banks are the proper people to finance planters. They are opposed on grounds of policy to tying up their funds on long-term mortgages, for that is what it amounts to. Let me cite in support of this particularly the experience of a group of three freehold estates whose normal annual crop of copra is about 1,500 tons—worth, even at present prices, about £15,000 per annum. Financial accommodation was required and so the plantations' bankers were accordingly approached for a loan of about £10,000. The bank refused to make any advances at all on the

security of these three plantations in Taveuni. The difficulty is that advances to coconut planters belong to the class of business known as long-term mortgage business, not really banking business.

Here, then, is a perfectly legitimate method of aiding the coconut planter. Let the Government take the present unrivalled opportunity of getting cheap money in London and transfer that money at a premium of 10 per cent. into Fiji currency. I would estimate the sum required at £100,000 in Fiji currency. A loan of £90,000 in London would provide this and the premiums would cover the costs of issue; I believe it could be obtained at 4 per cent. Let the proceeds in their turn be lent to planters at 4 per cent. interest plus a sinking fund of 2 per cent. and set a limit of two-thirds of the value of the plantation as the maximum amount which could be borrowed. Values cannot go lower than they are to-day and copra is a necessary commodity of this world to-day. So long as civilisation remains in its present state, a coconut plantation forms good enough security for such a loan.

My second proposal is in connection with the improvement of the quality of copra shipped from Fiji. His Excellency said yesterday, in opening the Agricultural Show: "I know that in Fiji we have the goods, but we must advertise those goods." Exactly. We can produce copra in Fiji—you saw it yesterday at the Show—that is the equal of the world's best. Further, that copra can be produced in commercial quantities. This is shown by Unilever's report that copra from Mua Estate contained as low as 1·2 per cent. free fatty acid. Unless, however, sufficient copra can be amassed to make up regular parcels of 100 tons, there is nothing to make it worth while for the crusher to seek for isolated parcels of high-grade Fiji copra. This brings us to the vexed question of grading once again and of separating admittedly good copra from admittedly low-grade copra. In Fiji there is only one logical place at which this can be done and that is the place at which the copra is received for export. This grading can be done for the expenditure of a few pence per ton and I will now suggest a method by which that grading can be introduced and popularised. I shall call it "the method of painless extraction."

Three grades of copra might be standardised—call them what you like—but for the present, let us refer to them as the top, the middle, and the bottom grade. Let the Government decree that there shall be an export tax of 5s. per ton for the bottom grade. Let the middle grade be exported tax-free, but to the top grade give an export bonus of 5s. per ton. Human nature being what it is, such a scheme provides that necessary urge of self-interest, and I predict the average quality of Fiji copra would quickly improve. As to the cost, let us suppose our average production to be about 25,000 tons per annum. With sufficient inducement we might reckon that 5,000 tons per annum would receive the additional attention required to class it in the top grade, so that the quality bonus would only require £1,250 per annum. This would be met to a certain extent by the export levy on the bottom grade copra. You will now see why I describe this method of introducing and demonstrating the value of grading as "painless extraction." May I now quote from His Excellency's address to the Legislative Council on October 3rd:—"The Government regards it as important that steps should be taken to raise the standard of quality. It considers that the present time is not opportune for introducing compulsion." Time does not permit me to do more than throw out these bare suggestions, but I do urge that they be considered and weighed in a truly helpful spirit.

CATTLE.

By Edward Duncan, Esq.

The present position of the cattle industry in Fiji (especially beyond the confines of Vitilevu) is, I fear, exceedingly precarious. According to the last census, eleven years ago, there were approximately 80,000 cattle in the Colony. The numbers have undoubtedly considerably increased since, but on a muster of that number, 16,000 fats yearly would be a moderate estimate of the number available for butchering. I do not believe that the actual number consumed within the Colony exceeds 6,000; so that 10,000 head, worth, approximately, say, £50,000, are wasted annually. With an assured market, I estimate above figure 16,000 would be doubled in five years.

A majority of the cattle producers are now, it is believed, at the cross-roads of continuation under export conditions, and curtailment, if not partial abandonment, of the industry. For the great bulk of our cattle, there is no market at any price. In those districts lying beyond the island of Vitilevu, the costs and risks of existing transport of cattle to market (Suva) are so great, so irregular and so unsatisfactory generally as to preclude the sale of fat cattle to the butchers.

Even if the butchers would regularly buy outside cattle (which they do not) the freight, insurance and other charges would be prohibitive. For instance, a fat bullock from beyond Vitilevu weighing 400 lb dressed weight, costs 35s. to land in Suva, and assuming that 20s. per 100 lb was received for it at the freezing works, the balance must be but 45s. to the producer, surely an inadequate return.

The position of the cattleman on Vitilevu is much better and will further improve on the completion of the new overland road. At present, the cost of bringing cattle overland from the extreme north or west coasts of Vitilevu is reliably said to be from 6s. to 8s. per head, thus leaving a balance of about 30s. per head in favour of the land as opposed to the sea transport.

Surely it should be the aim of the Government to help the outlying cattlemen to equality with Vitilevu in this respect. But the real crux of the surplus cattle question is "markets." If the industry is to be properly safeguarded, and if the herds, or majority of them, are to be prevented from degenerating into "scrubbers," and if cattle raising is to be encouraged to expand to the limits of the suitable lands and its intrinsic possibilities, especially as regards the native Fijians, who should be more generally taught cattle husbandry with a view to assisting Child Welfare schemes as well as their incomes, and if the utilisation of the waste land of the Colony, especially in the outlying islands, is to be properly encouraged, and if the extension of the existing coconut and dairying industries is to be stimulated, outlet must be provided for fat cattle. There can be only one way of doing this, and that is by providing for the export of our surplus as chilled, frozen and canned beef products to England, where these now obtain, or soon will, substantial Empire preference.

Cattle are an essential complement to the weeding and economical working of coconut plantations, just as surplus non-milking cattle are an inevitable, and should be a profitable adjunct to, let us hope, our continually expanding dairying industry. It appears, therefore, that provision should be made without delay for assuring markets for these products. The moment seems opportune and entirely favourable for meeting the situation which I have here briefly outlined, in that co-operation should be readily secured between

the Suva Municipal Council, the Government, the banana and other fruit shippers, the dairying companies, and the coconut-cattle and other cattle people.

The Town Council is contemplating the erection of new municipal markets and has discussed, it is understood, the provision of municipal abattoirs, both of which facilities essentially require cold storage. The Board of Health, an official organisation, has already taken up the question of a central abattoir for Suva and Rewa, at least so we have heard. The Agricultural Department and chiefly banana, but also most fruit exporters, are endeavouring to arrange exports to far distant markets, such as Vancouver, Victoria, &c., and for this purpose must have preliminary cold storage.

The export of butter requires cold storage, and if the cattle industry is to expand as it should, and as there is scope for, in fact, if the latter industry is to be prevented from retrograding, cold storage on the wharf reclamation, and abattoirs as close thereto as is sanitarily possible, will be necessary.

I have seen plans which the Director of Agriculture has prepared which, with some additions and perhaps modifications, would provide splendidly all the facilities I have outlined in this paper. The cost of the combined scheme, exclusive of cheap and rapid shipping facilities might, for a start, be restricted to £15,000; while for the abattoir and boiling down plant, if Leyland's abattoir was taken over, which should be possible at a reasonable cost, seeing it would otherwise be thrown into discard, an additional sum of £3,000, or £18,000, in all should be ample.

Initially, perhaps, £12,000 would cover costs if small scale provision, adaptable to expansion as required, were considered preferable. This money could be most readily, perhaps, procured by borrowing from the Immigration Fund. The interest income from this fund must to-day be in the region of £4,000 per annum. It is the property entirely of the sugar and coconut people, at least half of the latter interest being that of the native Fijian producers. It would, therefore, be not unfair, in the interests of the natives and the coconut-cattle people of the Colony, if £20,000 were borrowed from this fund at 4 per cent. interest and 1 per cent. amortization, or, say, £1,000 per annum, to pay for such facilities; especially if the Government here and the Empire Marketing Board came to our assistance with an annual subsidy or grant of £500 per annum between them. I believe that almost from the start the Government would recoup the subsidy in increased income from development of vacant and waste lands, and from enhanced exports and imports, and of course Fijian lands would benefit.

So strongly do I feel that the benefit and success of these proposals would be immediate and far-reaching within the Colony, especially as it is undeveloped and peculiarly adapted to cattle raising and has already existent on many out-lying islands of the Group the nucleus of cattle herds, that I could go on longer than you would relish elaborating the scheme.

However, my time is limited, even if your patience were not exhausted, and I must finish. I would like you, however, to remember that the scheme is vital to the coconut and dairy people throughout the Group; and in the well-being of the Fijians would help greatly towards the provision of milk for Child Welfare. Fijians are being taught animal husbandry, but the teaching needs speeding up, especially for their domestic purposes, till such time as they possess herds of cattle comparable with those of their African or local Indian compeers, when meat export would assist them also.

FRUIT AND MINOR CROPS.

By A. C. Barnes, F.I.C., B.Sc., A.M.I.Ch.E., Director of Agriculture.

It falls to my lot to deal with the subject of bananas, citrus fruit, pineapples both fresh and canned, and other of the less important products of the Colony which are finding their way in increasing quantities to the export markets.

On the subject of bananas you have been told on former occasions that the industry has suffered severely from the adverse effects of climate during the past two years. During the year 1931 some 97,000 cases of bananas, a little more than one-third of the normal annual output, were exported to New Zealand. During the first six months of 1932 some 101,000 cases were exported to New Zealand, an indication that production is on the increase and that plantations have made rapid recovery from the damage sustained during the period I have already mentioned. One unfortunate feature of the banana industry this year is the exceptionally heavy incidence of disease. The old so-called " Sigatoka disease " has again made its appearance and is still the subject of considerable argument in regard to its diagnosis. We are not satisfied that the leaf spot condition of the leaves has anything directly to do with the condition of the fruit which makes it unsuitable for transport, but we must admit that the two conditions are very closely associated. The Agricultural Department has been particularly fortunate in having under its immediate control one of the most badly infected plantations in the whole of the Group—a picture that would daunt the heart of the planter, but one which delights the scientific officer. Not only have we leaf spot in considerable evidence but we also have the banana borer in a plantation that we started off with freedom from that objectionable insect. Moreover, the scab moth which causes considerable damage superficially has been in great evidence. We have definitely demonstrated, I think, that the scab moth is perhaps more evident in the warmer weather, but still evident to a lesser extent in cool weather. In the case of the borer we have proved that trapping will effectively control the insect. With regard to the scab moth—and here I am deeply indebted to the Government Chemist and Government Entomologist—a simple method of control appears to be preventing the hatching of the eggs. Bunchy top, another disease which is present in some quantity, is under observation and valuable information in regard to its control has been obtained, but whether that statement will be borne out by later experimental work is a matter for conjecture. We are of opinion that the Fiji banana is developing year by year an increasing resistance to bunchy top. At Navuso some five acres of bananas have been planted with different varieties and there one finds every recognisable disease of bananas in Fiji as well as every objectionable pest; but we do not regard that plantation as a commercial undertaking but as our field laboratory where we can investigate these diseases and pests, and endeavour to improve the quality and appearance of the bananas exported from the Colony.

Turning to banana markets reference has already been made to the trials that have taken place in regard to the exploration of the possibilities of Vancouver for the profitable disposal of Fiji bananas. We were told, as we have been told in New Zealand, that Fiji fruit is undoubtedly superior in texture, but that it suffers by its appearance. That appearance is due to faulty methods of handling the fruit in Fiji. The industry as you know is very largely in the hands of Fijians, but Chinese, Indians and Europeans are now going in for banana cultivation to an increasing extent. There is no question that the Vancouver market is open to us and the substantial preference granted by Canada on Fiji bananas would enable us to compete with

the normal supplying territories, but we must get over the local difficulty of careless handling and I appeal to all shippers and growers to co-operate with the Department in its attempts to improve the appearance of the Fiji banana.

It is significant that inquiries have been received for Fiji bananas from Los Angeles, shipments to be made by the Matson steamers. I hope by the return of the vessel which left Suva for Melbourne the other day to arrange for the first trial shipment of a few cases of Fiji bananas in cold storage to what may prove to be a new and valuable though nevertheless somewhat restricted market.

In New Zealand marketing conditions have been difficult and the Fiji Government has had voluntarily to impose a quota system for the export of bananas to that country. His Excellency in his address to Legislative Council said that the system had worked with success. Since than a further shipment under the quota system has taken place and again, although there were minor difficulties inseparable from a system such as this, everything passed off with commendable smoothness and I would express my indebtedness to the banana shippers for the manner in which they have accepted the decisions of the Inspector of Produce and his staff. The transport of bananas from outlying districts to the point of export will continue, I am afraid, to be a matter of some difficulty, until the growers combine to make up economical loads suited to the accommodation of the vessels which ply between these more distant parts and the port of Suva.

Turning now to the question of citrus fruit: I am confident that Fiji, with a little determination, can build up a profitable market in New Zealand. Although the greatest number of cases of citrus fruits—oranges and mandarins—exported to New Zealand was between 8,000 and 9,000 cases a few years ago, this year the number was just over 3,000, and I think with little difficulty, now that we are assured of profitable returns to producers and shippers, we can attain to 10,000 cases in a season without planting any more trees. This is a valuable industry for those Europeans who are willing to wait just a few years for a return on capital invested. I wish to give an assurance to the effect that the regulations in regard to the export of citrus fruits will not be relaxed, but that we hope year by year to improve still further the quality and appearance of the fruit which is exported. Signal advance has, I think, recently been made through the kind assistance and co-operation of the Publicity Board who offered a special prize for the best design for an orange wrapper to be used for fruit exported from the Colony. The designs submitted for competition were shown at the Fiji Show yesterday and I think everyone will agree that the one which took the prize is a design which will immediately attract attention and will indicate to the purchaser the merits of the fruit and be a guarantee of quality.

I am sure that we can look forward with every confidence to wider markets than hitherto. Some years ago Australia shut the door against Fiji mandarins. It is unfortunate to have to report that a serious mistake in the diagnosis of a disease of citrus was made—citrus canker. Later inquiries show that citrus canker is not present in Fiji and endeavours are being made to secure the removal of the Australian embargo on Fiji mandarins. Mandarins exported to Vancouver during the past season met with a very favourable reception.

With regard to the export of fresh pineapples the Department has taken action with the object of avoiding some of the damage resulting to the fruit through bad harvesting and transport. Our Inspectors have been sent to country districts and have advised the growers, who are principally Chinese, Indians and Fijians. A system of grading has been introduced and we have

endeavoured, as far as possible, to see that the fruit leaves the Colony in reasonably attractive packages and in a thoroughly sound and unbruised condition. I think that everyone will agree that steps such as these are directly in the interests of the shippers and producers.

The canned pineapple industry is, I am convinced, one of the coming things in Fiji. We advertised the Fiji canned pineapple at the Ottawa Exhibition and we have succeeded in marketing canned pineapples in quantity in Canada. Inquiries have been received for even greater quantities than the local industry can supply. It is with regret that I have to record the collapse of one of the pineapple companies, but I would make it clear that the cessation of operations had nothing whatever to do with the quality of the fruit or the suitability of the soil and climate, but was entirely due to some other conditions to which it would not be proper to refer here.

As a result of the Exhibition staged at Ottawa a number of inquiries in regard to Fiji canned pineapples have been received and certain criticisms have been offered. These will in due course be passed on to the interested people. So far as quality, general appearance of the pack and suitability of our pines for the market, the merchants were lavish in their praise and I think interested people locally should feel very pleased.

I must now pass over for a few minutes to the cotton industry, which is at present at the turning of the ways from Sea Island to a new variety, and at the turning of the ways there is to be a pause, for during the coming season at any rate it is proposed to suspend the cotton ginning and marketing business as a commercial undertaking. The only variety which we can grow at present is Sea Island, and the market prospects for this crop are poor. In the West Indies a conference was recently held in order to find some means of overcoming the difficulties of over production and low market prices. After the fullest consideration it was considered wise to advise His Excellency the Governor to suspend for one year the commercial cotton growing business. During that year the new strain developed at the Cotton Experimental Station will be planted on selected Fijian farms and by the end of 1933 we hope to see a revival or reopening of the cotton ginning and marketing business as a commercial undertaking. It is proposed that the Sea Island strain should be kept in the Colony and this will be planted in selected areas to maintain a sufficient supply of seed. The Indian producers particularly interested in this crop are advised to exercise patience. I feel very strongly that the action taken is entirely in their interests and if they can for one year turn their attention to some other form of agricultural activity they should see a profitable revival of the cotton industry in Fiji.

I would refer briefly to rice. The crop this year has proved a record, but here again growers must be prepared to pay more attention to the conditions under which their crop is grown, harvested and marketed. Growers are advised to plough-in all old rice plants before they attempt to plant the crop for the ensuing year. It has unfortunately been necessary for the Government Rice Mill to decline to purchase quantities of paddy grown at Navua, one of the largest producing areas in the Colony. A conference between the Indian growers, the District Commissioner (Mr. Howard) and myself was held recently and the growers admitted that this was due to their fault. They agreed that the paddy was not worth purchasing and undertook to do better next season. We, for our part, have undertaken to supply seed rice in return for commercial paddy, quantity for quantity, and those growers who wish to continue to plant rice may obtain supplies of pure line seed provided they will undertake to cultivate their land properly and return an equivalent quantity of paddy.

The subject of maize was under discussion at the business meeting of the Convention this morning. I think the time has arrived when we must consider whether maize is to be continued as an agricultural industry of the Colony or not. If it is to continue we must look to the market in New Zealand and we must meet the requirements of that market as to cleanliness and absence of weevil. The question of the installation of a conditioning and drying plant at Suva is a matter for consideration and I shall be glad to receive suggestions from any person interested in the industry.

With regard to tomatoes, hitherto large quantities have been exported to New Zealand and Australia, but as everyone knows who keeps a garden this has been an exceptionally bad year for tomatoes. The Agricultural Department has endeavoured to improve the quality of tomatoes by seed selection at the Navuso Experimental Station, and I hope that acclimatised seed will shortly be available to those growers who require it.

In this brief review of what may be called minor crops I have only been able to touch on the principal ones. There are many others to which reference might be made but time does not permit.

WEEDS IN RELATION TO AGRICULTURE.

By H. W. Simmonds, F.E.S., Government Entomologist.

I have to-day been honoured with a request to address you upon the subject of "Weeds in Relation to Agriculture" by which word "agriculture" I understand to be included not only agriculture proper, but also all those pursuits in which the soil is used for cropping, such as horticulture, grazing and planting. Before proceeding with my address, it would be well to state what one understands by the word weed. This I should define as "any unwanted plant occupying land and thereby interfering with the normal crop which it is desired to grow upon such land." The important point is that a plant only becomes a weed when it interferes with other cultivation. Elsewhere it may itself be actually cultivated for its beauty or as a commercial proposition. Two of our Fijian weeds of major importance, *Acacia farnesiana* and *Psidium guyava*, are elsewhere grown for scent production and fruits respectively.

Some weeds are plants which have escaped from gardens, examples of which are Lantana and Water-hyacinth in Fiji, Foxgloves in New Zealand, and Gaillardias in Hawaii. I have quoted these in order to stress the point that it is only when a plant interferes with the normal activities of the agriculturist that it becomes a weed. At other times and places it may (and many do) perform useful functions, preventing soil erosion, and storing plant foods which would otherwise be washed out of the soil and which again become available at the death of the plant.

Weeds also play a useful part in the regeneration of natural forests by quickly covering abandoned clearings, first with quick-growing annuals, followed by shrubs of more woody growth, under which shelter, forest tree seedlings find necessary shade and protection until such time as, overtopping the plants which have acted as their nurses, they eventually replace them, and the country reverts to a condition more or less approximate to its primary state.

TYPES OF WEEDS.

In the different classes of cultivation, arable, pastoral and plantation, very different types of plants are likely to render themselves sufficiently objectionable to be classified as weeds. In arable land, plants of this nature are normally quick-growing annuals, and such also are the first to appear in new plantations. Here, however, the re-generation of forest conditions is apt to proceed further, and a heavy growth of woody shrubs to replace the annuals.

In grazing lands, only such plants as are objectionable to cattle are likely to become troublesome, and this may be due to poisonous or distasteful qualities or the presence of hairs or thorns.

ORIGIN OF WEED PLANTS.

In the big land masses under the changed conditions brought about by human agency in destroying the native forests in order to establish plantations and farms, certain native plants, normally the occupants of the poorer country, have invaded the newly created clearings to such an extent that they become troublesome. Examples of this are Lalang in the Eastern tropics, and thistles in Europe.

In the smaller land masses, however, most of the major weeds are of exotic origin, being generally immigrants from the larger areas. Such plants, the product of a more severe competition, have developed means of protection which render them highly dominant when they enter a new country, especially if it is specifically more sparsely populated. Further, in migrating, they frequently leave behind a host of enemies, specialised or general, and failing to meet an equally intensive attack in the new environment, produce more seed and spread with greater rapidity than they would be able to in their own homes.

In Fiji, I think that all our weeds are of exotic origin and it would be well to consider why these have become troublesome. In almost every instance, it will be found to be due to some special means by which the seeds are rapidly dispersed. Some of these are by wind, but certain birds, particularly the imported Indian Mynah, which is an inhabitant of cultivated land, have found the fruits of Lantana and *Clidemia hirta* a palatable food and have scattered the seeds of these plants far and wide. *Solanum torvum* also is spread by bird agency, particularly native pigeons and introduced doves. Guava is carried by cattle, as also are certain other plants, whilst it is probable that the Flying-fox is also a culprit.

Some plants produce seeds capable of lying dormant for long periods and this has caused some of these to become troublesome. Particularly is this the case with Sensitive Grass (*Mimosa pudica*) and Vaivai (*Leucæna glauca*).

CONTROL OF WEEDS.

Having lightly touched upon the factors which cause a plant to become a troublesome weed, I now propose to discuss the control of such plants in cultivated lands. In arable land many of the operations necessary to agriculture are partly directed towards the destruction of unwanted plants as well as the conservation of moisture and the aeration of the soil. Such operations are essentially aimed at the destruction of the weed before seed production takes place. There is an old saying, "One year's seeding, seven years' weeding," and this carries much truth. Where holdings are small, the cultivation is normally sufficient to hold weeds in reasonable control and in densely populated countries such as Java one hears little of "noxious weeds."

In pastoral lands, however, holdings are generally large, and weed control becomes more difficult, especially as cattle, being selective feeders, are bound to lead to the protection of unwanted plants. Sometimes, however, use can be made of cattle as has been done in New Zealand, where by close paddocking, firing and heavy stocking, bracken has been successfully controlled. Where, however, such methods are not practicable, resource must be had to manual destruction, if possible, prior to seeding.

In plantations various methods are adopted in different parts of the world, such being clean weeding by hand, the use of cover crops or the regular cutlassing of the undergrowth, and thus returning their plant foods to the soil. In Fijian coconut estates cattle have long been used as weeders. In view of their selective feeding, however, they are bound to give rise to the increase of certain objectionable plants, necessitating hand weeding.

Such practices are all necessarily expensive and it is not surprising that planters and graziers in many parts of the world have turned their thoughts towards biological methods of control as a solution to their problems. It must be admitted that the idea is attractive: a period of investigation, the introduction of an insect, and the disappearance of the weed with no further expenditure.

It is, however, not quite so simple as that. This method is still largely in the experimental stage, and, at best, can only be used against a very limited number of plants without danger. I use the word "danger" advisedly. Only three years ago, in June, 1929, Dr. Myers of the Imperial Institute of Entomology, in an article on the biological control of insects and weeds, said: "*It cannot be too strongly emphasised that all are either in the experimental stage or may be dismissed as valueless save the control of insects and other arthropods by insects.*" The italics are his. He goes on to say: "It is far too frequently forgotten that this, and this alone, is the only sound general practice in biological control. To this must be credited every one of the sweepingly successful applications of the principle." Later on in the same article he says: "The control of weeds by means of their insect enemies is still entirely in the experimental stage."

That was in 1929. More recently, on the 12th of July of this year, Professor Silvestri, one of the pioneers of biological control and the leading Italian authority on this work, in a lecture given at Wye, in Kent, stated: "Biological control of noxious weeds is, I should like to repeat, very dangerous, and it further requires the employment of the best trained entomologists, but as the results of experiments here stated show, it is worth the fullest consideration on account of its economic importance."

I have quoted the above opinions recently expressed by two men with a world-wide reputation in biological control work, to show how serious a view they take of attempting to control plant life by such methods, and it is not until other methods have been completely exhausted that resort should be made to the importation of insects for the purpose, for once imported, it is generally impossible to eradicate them should they become undesirable.

As a general rule, I think it can be said that plant-feeding insects are not so highly specialised in relation to their hosts as are those which parasitise other insects, but if one of these latter attacks some insect other than the one that it was imported to control, it is seldom that great harm will result. If, however, an insect imported to control a weed turns its attention to some other plant the damage done may be irreparable. That such may happen is shown by the case of *Thecla echion*, imported into Hawaii to destroy the

flowers of Lantana, which has, since its introduction been found attacking Brinjal, an absolutely unrelated plant, one being a Verbena and the other a Solanum.

Another instance of unexpected diversity of habit occurs in the larvæ of the moth *Mompha trithalama*. When investigating *Clidemia hirta* in Trinidad, Taylor found these larvæ causing galls in the stems of another Clidemia, *C. pustulata*, and, as a result of investigation, believed the insect to be specific to that plant. I subsequently found the same species attacking the fruits of *Clidemia hirta* and forming no gall. Here we have an insect attacking two different but allied plants in utterly different ways, with other corresponding differences in habits.

Yet another instance of strangely different habits in the same insect occurs in the beetle *Elytroteinus substruncatus* which, in Fiji, bores into stems of begonias, but in Hawaii is a pest of ginger, and in the Cook Islands is recorded as attacking the fruits of lemons.

Again, an insect which attacks the young shoots of its host, causing die-back, may, if the attack is not sufficiently severe or is only seasonal, lead to branching and render the plant more densely shrubby, leading to a greater flowering and seed production. Such has, I consider, occurred in the case of one insect introduced into Hawaii against Lantana.

Yet another danger in biological control of weeds must be pointed out, and that is that when the plant to be controlled covers large areas, and the controlling agency is one which actually kills the plant, the result of the introduction, if successful, is the sudden opening up of these large areas for colonisation by other plants. Now, the plants most likely to take advantage of these newly-opened lands are other weeds, and this will be even more so if cattle are allowed to wander freely and so prevent the growth of the more desirable plants. As instance of this damage, I must again quote Hawaii, where, as a result of drought, fire and biological agencies, certain poor lands formerly covered with lantana became exposed. In many cases, this land was occupied by Guava and *Acacia farnesiana*, two infinitely worse weeds. In Australia also, where control of prickly pear by biological agencies has been so successful, it has been found that if fire runs through the masses of dead pear a dense growth of Mallee type comes up, even more difficult to handle than the weed was. In Fiji also, on certain waste lands and by the roadsides, *Clidemia hirta* is being replaced by Stachytarpheta (Blue-rat Tail) and *Solanum torvum*, the latter certainly far worse than the *Clidemia*.

I have pointed out the above dangers, not to minimise the value of biological efforts in controlling certain weeds, and in which efforts I am a strong believer, but to show that the work is one requiring much time, thought and patience, and to show something of what it is necessary to guard against. I think I can say that until comparatively recently, most entomologists were more or less strongly opposed to its employment, feeling that the solution of the problem lay in closer settlement. In 1930 I had the honour to represent this country at the Third Entomological Conference in London, and there listened to the remarkable results which have been achieved in Australia against prickly pear; and these results must have convinced all present that under some circumstances biological control of weeds is sound and practicable. Since then, the results of our own attempts against *Clidemia hirta* are meeting with success comparable to that achieved in Australia.

I will now discuss a few of the limitations necessarily imposed upon the work:—

(1) It is absolutely necessary that the plant to be controlled belongs to a group containing no economic plants of importance.

(2) It is also necessary either that the plant be an importation and that the insect to be used comes from the original home of the plant, or if a native, that the insect which it is proposed to introduce is an enemy of a very closely allied species in its own home. The introduction of an insect which attacks a plant in a land not its original home would mean that it had other host plants and would show an adaptability which would render it very dangerous.

(3) It is safest and advisable that the proposed controlling agency shall attack the flowers, fruits or seeds and thus prevent seeding. This will not give the spectacular control exercised by insects attacking leaves and shoots, and, except with annuals, will necessitate much manual clearing. It will, however, if efficient, reduce reinfestation, and that is, in my opinion, the real objective of biological control of weeds.

Before closing, there is one more point I wish to bring to your notice as practical men, and that is that if the bilogical control of a weed is to be successful, it is absolutely necessary that the plant be quickly replaced by useful growths. To that end it may be necessary to cut it by hand, or to fence and exclude cattle. In other places, it will be advisable to plough and sow grass or to put in a cover crop. The planter should look to the new introduction only to prevent reinfestation of his land with the old weed. He should do all in his power to get his land quickly covered with useful plants and so prevent the establishment of other weeds.

In this address I have said nothing of the necessity of the controlling agency being confined to the species or group which it is desired to control. As in many cases such specialised agencies may not exist, a further limit to the application is imposed. Nevertheless, despite the limitations which I have mentioned, there are weeds not related to our cultivated plants, which will, in certain instances, repay research with a view to the employment of biological methods for their control, always remembering that such methods are limited in their employment and only to be used after careful study and thought.

His Excellency, in closing the meeting, said that he wished to express his very great thanks to the gentlemen who had been so good as to read papers. He had listened with the greatest interest and was sure that everyone had done so to Sir Maynard Hedstrom's excellent advice on the matter of dairying in Fiji. Every dairy farmer in the Colony would be interested in the question of herd testing. He did not wish to say much about Major Joske's paper on coconuts, but there was just one thing, and that was that he would like to see closer union among the coconut planters. He thought that individuals were not able to make the same progress as a company and if " Taveuni Limited " was formed the people would be in a much stronger position. He thanked Mr. Duncan for his valuable paper on cattle and which raised questions to which he would give most careful consideration. He said that Mr. Barnes had raised many interesting points about citrus and he agreed that a good hard working man who was prepared to wait a little time for returns should do well out of this industry. Of course, he recognised that it was a question of capital at the beginning. Mr. Simmonds had set out some most useful points in connection with weeds and showed how necessary it was to investigate thoroughly the position before any parasites were introduced to help to eradicate weeds.

FOWL POX IN FIJI.

By C. R. Turbet, B.V.Sc., Senior Veterinary Officer.

As a menace to the health and lives of poultry, fowl pox is probably the most important to the poultry breeder in Fiji. It is also known under the names of contagious epithelioma, sore head, warts or chicken-pox. The disease is practically of world-wide distribution in the tropic and temperate zones.

Losses.—The losses experienced in Fiji from unimmunised birds varies greatly. Some outbreaks, particularly in older birds, are mild and no mortality occurs. With young birds from two to three months old, losses might be anything from 10 per cent. to 90 per cent. Since there are few large flocks in Fiji the losses are distributed among many owners of small flocks, and as a result there is no great blow to any one owner. Hence, the serious mortality which does occur is not brought home to the individual or to the public. With the development of larger flocks, when hundreds of chickens are raised on the holding, introduction of the disease among non-immunised birds would be a very serious blow indeed to the owner.

Many poultry farmers believe the disease to be caused by the mosquito. This is not the case, although the mosquito plays a most important part in the spreading of it. Investigators have recently determined that fowl pox can be definitely transmitted from infected to non-infected non-immune birds by the bites of mosquitoes which have previously fed on infected birds. The mosquito capable of causing this transmission is unfortunately common in Fiji and they are able to carry infection for fourteen days following a meal on a diseased fowl.

The severity of the disease is due to the general systemic disturbance which occurs as a result of the presence of the virus in the body tissues, the actual irritation from the extensive sore and inflamed areas, and to impairment of vision and feeding ability when the lesions affect the eye and mouth of the bird. It is much more severe in young birds than old.

Fowl pox occurs more commonly in the early summer, coinciding usually with warm, moist conditions favourable to mosquitoes and the period in which chickens are commonly raised in this country. It will be seen therefore that late chickens are more liable to severe infection than those hatched in June and July.

For many years this disease had been treated by various local applications, in an endeavour to dry up the scabs and cause them to fall off, whilst drugs such as Potassium Iodide, Epsom Salts, and others have been given in an endeavour either to ward off or treat the disease. Although these older methods are still in use, modern tendency is towards the control of fowl pox by preventive innoculation.

Our early methods in Fiji to control this disease by innoculation consisted of the innoculation of susceptible chickens with a vaccine made locally by grinding up scabs from an infected bird in a mortar and making a saline emulsion of this. Part of the virulence of this material was destroyed by heating to a certain temperature. One cubic centimetre of this material was innoculated under the skin of the breast of the chickens to be immunised. Although some success was obtained with this method, comparatively large quantities of the vaccine were required to treat large numbers of birds, and results were not constantly good. New methods of immunisation began to appear in veterinary literature and following the reports by Doyle, Beach

and others, in the Proceedings of the 11th International Veterinary Congress in London, 1930, it was seen that several improved methods were available. Doyle's method was briefly the immunisation of fowls against fowl pox by vaccination with virulent pigeon pox virus. The method reported by Beach and others has as its basis the use of an unattenuated fowl pox virus. Owing to the unavailability of pigeon pox virus and to the danger of infecting our fine wild pigeons by the use of virus virulent for that species, it was decided that we should endeavour to immunise by the use of one of the fowl pox virus methods. The Veterinary Division has therefore prepared a vaccine from the virus of locally occurring cases which from our trials we consider is effective in conferring immunity.

In 1931 the Biological Institute of Australasia communicated with us on the subject of immunisation of fowls against this disease, and as a result that Institution forwarded to the Veterinary Division a supply of fowl pox vaccine made by them from a Fiji strain of the virus of the disease and a series of experiments were also conducted in Suva to test the potency of that vaccine.

Two different methods of actually administering fowl pox vaccine were tried. In the first, known as the " stab " method, two very small stab wounds are made on the outside of the fleshly leg in a transverse direction, about half an inch apart. The instrument used is a lancet-shaped knife sharpened on both edges. Around this blade about 3/32 of an inch from the tip, a small piece of adhesive tape, and over this in turn fine thread, is wrapped. This wrapping serves the double purpose of preventing the wound being made too deeply and at the same time carries the charge of virus to infect the wound made by the lancet. The second method, known as the " feather follicle " method, consists in the plucking of a few feathers from the outside of the fleshly part of one leg in approximately the same region as would be chosen for the " stab " method. The virus is applied to the open feather follicle by means of a camel hair brush, which has been dipped into the virus contained in a fluid form in a small phial.

The former method is more economical in vaccine consumption but has the disadvantage of requiring a special instrument. The second method appears to have no disadvantage and is the one preferred by the writer.

The dose of virus given was calculated as ·01 cubic centimetres by the stab method and ·02 cubic centimetres by the feather follicle method. In other words, one cubic centimetre would be sufficient to vaccinate 100 birds by the first method or 50 birds by the second method.

The following is a brief account of some of the writer's experiences in Suva with the vaccine:—

(1*a*) On 4th March, 1931, ten adult hens were vaccinated by the stab method using approximately ·01 c.c of vaccine. These birds were probably already immune. There were no vaccination takes and no disease appeared.

(1*b*) On the same date as (1*a*) four pullets hatched on 4th December, 1930, were vaccinated by the same method. These were showing early lesions of the disease at the time of vaccination. The fowl pox lesions cleared up. None showed vaccination takes or systemic disturbance.

(1*c*) Seven healthy chicks hatched on 28th December, 1930, were vaccinated as in (1*a*) and (1*b*) on the same date. They were later added to a pen containing (1*b*). On 19th April, they were examined and six showed typical vaccination takes. There was no take in one. None of these contracted the disease after contact with group (1*b*).

(2*a*) On 11th March, 1931, eighteen cockerels and pullets from five to six months old, all showing natural lesions in the early stage, were vaccinated by the feather follicle method, using approximately ·02cc. of vaccine. All natural lesions cleared up and there were no vaccination takes. (on 26th March). No mortality occurred.

(2*b*) On the same date and at the same yard, 23 adult birds were done. There were no lesions showing among these at the time. No vaccination takes appeared, indicating previously acquired immunity.

(3) Nine chicks two months old were vaccinated on 17th June, 1931, by the feather follicle method. Seven were showing early lesions at the time of vaccination. There was no mortality.

(4) Thirty chicks, about two months old, were vaccinated on 27th July, 1931, by the feather follicle method. Twelve of these were showing lesions when vaccinated and four of these birds died. The eighteen not showing lesions did not contract the disease. Twelve had vaccination takes. Eight of the twelve infected chicks recovered.

(5) On August 7th, 1931, twelve chicks, two months old, were inoculated by the feather follicle method, takes being obtained in each case. Three weeks later these birds were placed into a pen containing a batch of ten chicks about two months old which were naturally affected with the disease. Into this pen were also placed as controls four two months old healthy chicks from a flock where the disease was not occurring.

The behaviour of the chicks in this pen containing 26 chicks was as follows:—Of the ten naturally affected chicks three died, one recovered blind in one eye, and the remainder made complete recovery without treatment. Of the twelve immunised chicks all remained healthy, while of the four control chicks, all contracted the disease. One was destroyed owing to severe infection of both eyes and one died, whilst the others made gradual recoveries.

(6) On September 22nd, 1931, 22 chicks, 46 days old were vaccinated by the feather follicle method. None showed lesions of fowl pox at the time of vaccination. All had definite vaccination takes on 6th October. None developed the disease when exposed to four naturally infected chicks at a later date.

(7) On October 6th, 1931, 33 chicks, from three weeks to three months, were vaccinated by the feather follicle method. At the time of vaccination two were showing lesions of the disease. When examined on November 17th fowl pox was evident among the younger chicks. In this trial the vaccine did not protect the younger birds and it would appear that the vaccine had lost its potency due to age.

(8) On October 20th, 1931, 20 chicks, from two to three months old, were vaccinated by the feather follicle method. Eight of these were showing early lesions at the time of vaccination. Four of them died, the remainder having vaccination takes and did not contract the disease.

Conclusion.—From these experiences it will be seen that vaccination with a properly prepared vaccine which has not lost its potency through age or other cause is effective in providing an immunity against natural infection with fowl pox virus, and it would appear that vaccination has a favourable influence towards recovery in birds showing early lesions of the disease.

CITRUS CULTIVATION.

By B. F. Hooper, Assistant Agricultural Officer.

EARLY HISTORY.

At one time oranges and mandarins were exported from Fiji to both Australia and New Zealand. In consequence, however, of the presence of Fruit fly *Dacus passiflorœ* and *D. xanthodes* and the fact that Fiji was also credited (in error) with the Mediterranean fruit fly *Ceratitis capitata* the latter country demanded a certificate to the effect that no species of fruit fly occurred within one mile of the orchard in which the fruit exported was grown, a certificate impossible to give in such a country as Fiji, resulting in the closing of that market. Mandarins were, however, shipped to Australia for some years later until 1922 when owing to the inability of this country to give a certificate that citrus canker did not exist that market was closed. As however this disease is undoubtedly absent from Fiji it is hoped to eventually see that market also reopened.

REOPENING OF NEW ZEALAND MARKET.

When in 1921 the Government Entomologist visited Raratonga he observed the method adopted in that Group where another *Dacus* occurred as a pest of citrus. The New Zealand Administration was then approached and a somewhat similar procedure was suggested for Fiji. As a result the New Zealand market was reopened and a certain quantity of fruit exported under the new regulation. This was not altogether satisfactory owing to poor handling and uneven quality.

In 1931 the Department of Agriculture, Fiji, prepared, coloured, graded and packed a quantity of fruit from Nasinu, which was then shipped to New Zealand where it met a very encouraging reception. New regulations were then brought in making grading and colouring compulsory with most satisfactory results to shippers.

Hitherto all fruit has been obtained from seedling trees, scattered throughout the Group, such fruit being of course very variable in quality and appearance. If the industry is to be firmly founded, however, it is necessary that carefully cultivated groves of budded stocks be established and the following particulars may be of use and interest to intending growers.

ROOTSTOCKS.

As far as is known, Fiji is very free from root and trunk diseases; seedling trees grow luxuriantly showing an encouraging absence of root and trunk diseases. Until such diseases appear the question of rootstocks is a simple one. Sweet orange is the choice of all the varieties, although in most citrus growing regions, it is impracticable to use it on account of its susceptibility to root and trunk diseases. Sour orange stocks are now being used in most countries on account of their disease resisting qualities and, in the opinion of some growers, the fruit produced on sour orange stocks is superior to that produced on any other stocks. Its chief drawback, however, is that they do not produce rapidly growing trees on sandy soils. In South Africa sour orange stocks are a complete failure, rough lemon being the popular one in that country.

Rootstocks naturally influence the flavour and texture of the fruit, although in the case of a lemon stock, the influence is said to be lost after several seasons of fruiting.

THE SEED-BED.

The site of the seed-bed should be on good, well-drained soil, capable of producing first class growth of seedlings. In this country, where the rainfall is heavy, care should be taken that the site chosen is not too steep, otherwise, should heavy rains fall before the seeds are well up, they are liable to be washed away, thus entailing much unnecessary work and expense.

Prior to planting, the area should be deeply ploughed, care being taken that no subsoil is brought to the surface, and a fine tilth procured. The soil should be of a medium to light loam, free from stones of any size and without a hardpan. A heavy soil does not permit a good root development. The site should be protected from high winds so that normal straight development of the small plants may take place.

Whatever the variety of stocks to be planted, the ripe fruit for seed selection should be procured from vigorous and healthy trees. Seed can be extracted from the fruit by cutting the fruit nearly in half, twisting the halves apart, and working the seeds out with the fingers. Care should be taken not to cut the fruit entirely in half, as by doing so some of the seeds will be cut and rendered useless. Seed can also be extracted by placing the fruit in a barrel of water until the fruit has rotted; the seed is then removed by running water and a sieve. Only plump seeds should be kept for sowing. They should be planted as soon as possible after removal from the fruit, as any drying out before planting reduces the percentage of germination and causes a hardening of the seedcoat. Should the seeds unavoidably become dry, they should be soaked in water for one or two days.

In order to facilitate handling and tilling operations, seed-beds should be laid out in strips of five feet, a path two feet wide being left between the beds. The seeds should be sown fairly thickly in rows, eight to nine inches apart, the seeds being set about an inch apart in the rows. They should germinate in about four weeks. Should prolonged dry weather prevail, the area will require watering. Citrus seeds are polyembryonic, that is, some seeds give rise to more than one seedling. In such a case only the strongest of the seedlings should be allowed to remain.

While the young seedlings are developing, they must be given constant attention. Frequent weedings are essential, and the soil must be kept loose and friable.

When the seedlings are six to nine inches high, they can be transplanted into the nursery. This operation should be carried out after a heavy fall of rain. About twice as many seedlings should be available at this time as it is intended to plant, the weaker 50 per cent. should be discarded. At the time of transplanting the roots should be inspected for any restriction as any trees with deformed roots cannot be expected to equal those with a straight main tap root. Trees should not be grown in tins or other shallow containers as the root system is bound to be affected by such restriction.

THE NURSERY.

The site and cultivation for the nursery should be similar to that of the seed-bed.

As soon as the seedlings have been removed from the seed-bed and the tops and roots have been cut back, they should be placed in moist sawdust or wrapped in wet sacking, as exposure of the delicate roots to the air and sun is very injurious and will result in the death of many plants.

The seedlings should be set in rows three to four feet apart and 18 inches apart in the rows. Care must be taken that the seedlings are planted to the same depth in the nursery as they were in the seed-bed, and that no bending of the main root takes place when the transplanting takes place. The seedling should be placed in the ground and no pushing should be done under any circumstances. The opening in the ground is best made with a spade. Should the main root become bent at this stage, it will remain so permanently and will have to be rejected when the tree is transplanted as a budded stock.

Watering operations should be carried out immediately after each seedling has been transplanted, and, should dry weather prevail, the seedlings will have to be watered daily until they have properly "taken."

During the growth of the seedlings in the nursery all weeds must be kept under control.

Should any side branches develop whilst the seedling is growing to a budding size, they should be rubed off. This ensures a straight stem and expedites the time of budding as all growth is then concentrated in the development of a single stem.

When lemons, Seville oranges or grape-fruit are grown as stocks, they often develop a disease called Citrus Scab (*Sporotrichum citri*). This disease causes rough, wart-like, brownish protuberances on the leaves and young growth. Should it become serious and retard the growth of the seedlings, spraying with Bordeaux mixture, 4–4–50, should be done. The sweet orange is practically immune and can be budded safely on affected lemon, Seville orange or grape-fruit stocks.

Budding.—The modern, standard method of propagating citrus nursery stocks is by budding.

When the stocks have attained a diameter of approximately half an inch at the height at which the bud is to be inserted, budding may be done. Citrus may be budded at any time when the bark will "slip," that is, when it will separate readily from the wood. In the tropics, where no cold period of the year is experienced, budding can be carried out practically at any time.

The height at which the bud is to be inserted depends chiefly on the soil and climatic conditions under which the trees are to be planted. Low budding greatly increases the possibilities of root and trunk diseases, whereas high budding, say, at about 10 inches greatly minimises such dangers. The bud union is itself apparently physiologically weaker and more susceptible to infection than any other part of the trunk, and in Fiji, where a high rainfall is experienced and the top of the ground kept moist for long periods, it is wisest to practise high budding, moist soil around the trunk of the tree being a favourable factor in causing collar rot and dry rot.

Budding nursery stocks is accomplished by the insertion of a shield-shaped bud into an inverted "T" slot cut in the bark of the stock. Buds are cut from wood about the thickness of a pencil which has outgrown its angular condition. This is generally one year old growth. The bud wood should be selected from mature trees of a known calibre, bearing satisfactory crops of fruit true to the varietal type. It is impossible to judge trees by one year's crop, but records should be kept over a number of years in order to determine which trees are most suitable for propagation purposes. The importance of this is appreciated when the buds possess all the heritage of the parent tree.

The budding knife is of great importance. The blade should be of the very finest steel with a rounded end. The blade should be carefully ground and honed to a thin smooth edge and, if necessary, finished off on a razor strop. Unless the knife is of the finest quality and carefully sharpened it is impossible to make smooth cuts without leaving loose shreds which interfere with the union between bud and stock.

Budding tape for wrapping is made from thin calico torn into strips $\frac{5}{8}$ inch wide and impregnated with a grafting wax that will not harden. A very satisfactory formulæ is that from Hume's *Cultivation of Citrus Fruits*—resin, 1 lb; beeswax, 4 lb; and raw pine gum, 3 tablespoonsful.

In order to facilitate budding operations the trunks of the seedlings should first be pruned clear of thorns and leaves up to the height at which the bud is to be inserted. With the knife grasped in the right hand, a downward cut is made about $1\frac{1}{2}$ inches. This is the vertical cut. A cross cut $\frac{1}{2}$ inch is then made across the bottom of the vertical cut, thus constituting an inverted " T " shape cut. When making these cuts, care must be taken that they are not made any farther into the wood than is necessary to sever the bark completely. The bud is now cut from a budwood stick which is held with the basal end away from the operator. The cut is made toward the operator and as nearly as possible parallel with the axis of the budwood. This will give a shield shaped piece of wood and bark approximately one inch long, with a very smooth and flat cut surface. By starting the cut from the basal end, there is less likelihood of damaging the eye during the resulting lift of the bud, whilst cutting from the bud stick.

The bud is now inserted right side up in the stock. The bud shield, when inserted, is entirely beneath the bark and should be pushed far up into the vertical cut. Taping is started below the horizontal cut and continued firmly around the trunk of the stock up to above the vertical cut, and the tape is then brought back on to the cloth, thus making sure that it will adhere firmly. It is important that the wrapping be sufficiently tight to prevent the entrance of water into the wound and to hold the bud and stock closely together so that a callous growth will start and a union be formed. After about ten days, the tape should be unwrapped sufficiently to ascertain if the bud is still green and showing callous formation, thus indicating that it has " taken," the tape can then be removed. If the bud has turned a brownish colour, this indicates that it is dead and the work will have to be done again on another side of the stock. Should the bud fail to take the second or third time, the particular stock should be destroyed as continued failure indicates a degree of incompatibility between the stock and scion.

As soon as the bud starts to grow the top of the stock should be lopped six inches above the bud. As the bud shoot grows it is tied to the stub, but when it has grown higher than the stub a stake about 4 feet long and $1\frac{1}{2}$ inches wide is driven into the ground alongside the stock and the young shoot tied to it every few inches. This is done in order to ensure the formation of a straight trunk. The stub is then cut off, with a clean sloping cut, just above the top of the bud. When a seedling is very large when budded the top is sometimes cut only halfway through. This helps to start the bud and at the same time leaves some top to support the roots. The cut should be on the same side as the bud.

During the growth of the budded tree all side branches must be rubbed off as they appear. All new growths below the bud union must also be removed.

When the tree is about three feet in height, it is headed to about 30 inches from the ground. This can either be done in the nursery or in the field. This causes several shoots to be thrown out, of which three or four should be left and the remainder removed. These main scaffold branches should be spaced as far apart, vertically, as possible. The scaffold branches should not arise on only one side of the tree, but should be well distributed round the trunk, nor should they arise from a small space. If this is allowed to occur when the tree grows older a pocket is formed in which water collects, causing the decay of the wood. It also results in a weak head and correspondingly easy breakage of the main branches under a heavy crop or during strong winds.

In removing the trees from the nursery to the field, a ball of earth is sometimes taken around the roots. This procedure is largely followed in California, but it has a serious drawback in that the root system is unable to be inspected and the planter unknowingly plants some trees with poorly developed or deformed roots. As each tree is lifted from the nursery the roots should be inspected and, if any deformity is noticed, the tree should be discarded.

Care should be taken to select only the best trees in the nursery for planting in the field. To leave the smallest until they have attained a similar size is foolish, because such trees, owing to their inherent weakness, can never be expected to equal the more vigorous ones either in size or productivity, even though fertilizers be given.

ESTABLISHING THE GROVE.

As far as can be forecasted at present, intending citrus growers will establish their groves in conjunction with their present agricultural activities.

The success of a citrus grove depends largely on its location. If planted under unfavourable conditions, a grove will not give of its best even though it be given good cultural methods. In judging a soil for citrus fruit production, it is advisable to give it more than a cursory glance. It should be inspected to a depth of at least four feet; if such things as clay, rock, gravel or a hardpan be present in abundance, maximum results cannot be expected. A gravelly sub-soil allows the water to penetrate too rapidly to be of much use to the trees and the result is loss of plant food by leaching. An impenetrable sub-soil is apt to become waterlogged. Drainage is an important factor.

Should the intended location be subject to strong prevailing winds, it is advisable to grow wind breaks. These should be planted about 100 feet from the first row of fruit trees so that they cannot interfere with the young trees in any way. Windbreaks should be planted about two years prior to planting the citrus trees.

It is advisable to sow a leguminous crop the year before planting and this should be ploughed under at the commencement of the rainy season. This will considerably add to the fertility of the soil.

On fairly level land the square method of planting has much to commend it. Distances of approximately 20 feet are very suitable. This enables the free use of implements during cultural operations and also leaves ample room for vehicular conveyances during harvesting, cultural and fertilizing operations. Ample room at the headlands should also be available.

After the field has been lined out the holes should be dug; these should be at least two feet in diameter and two feet in depth. It is advisable that two weeks should elapse between the digging of the holes and planting. Just before the trees are to be planted the holes should be filled with surface soil and, in so doing, a small cone should be built in the centre of the hole,

as this considerably facilitates the spreading of the roots. As far as is practicable, trees should be transplanted whilst in a state of dormancy, thus reducing the number of misses.

When planted care must be taken that the roots are spread evenly and that no cramping takes place. Should any very long roots be present they should be cut off in order to avoid twisting. The soil should be firmly trampled round the roots, but excessive trampling is liable to injure the roots.

Whether the trees should be planted at the same depth in the field as they stood in the nursery is a point of much controversy. The modern rule is to plant the trees with the crown roots just under the surface of the soil, thus having the bud union, the most susceptible part of the trunk to diseases, as far above the ground as possible. In some countries the trees are planted with the crown roots exposed.

When planting operations have been completed a thorough watering should be given, to be followed by another watering in about two days should dry weather prevail.

As the trees are growing it will be necessary to inspect them from time to time for signs of disease and to rub off any young shoots that are not necessary for the building up of the tree.

Should inter-cropping of the young grove be necessary, through the limited resources of the grower, it must be borne in mind that two crops are being grown and the grower must not pay all his attention to the temporary crop and allow the trees to care for themselves. If an intercrop is to be grown it should be fertilized in order that the soil fertility is maintained. If maize is grown a leguminous manuring crop should follow. As the trees grow older more space should be left round each tree, until finally only a strip in the centre of each row is utilised for intercrops. The growing of Mauritius bean has much to commend it as the seed can be marketed and the bean straw turned under.

The intercropping of a bearing grove is not to be recommended.

Cultural Operations.—Whilst the grove is yet young it is desirable that a large quantity of organic matter be deeply incorporated with the soil. Ploughing to a depth of 10 inches is recommended. As the trees grow older the cultivation must be shallower as the roots are extending in every direction. In this Colony, where moist, humid conditions prevail, the majority of the roots are to be found in the upper five or six inches, consequently deep cultivation would be most injurious. Cultural operations should cease a short time before and after blossoming.

Under conditions of heavy rainfall, where there is sufficient moisture for both trees and weeds, very little cultivation is necessary in a bearing grove beyond keeping down excessive weed growth. It is necessary that either weeds or a leguminous crop be present in order to avoid soil erosion.

Pruning.—In general, evergreen trees require the minimum of pruning. After the young trees have been headed back and the main and secondary branches established, very little pruning is necessary beyond the removal of diseased, injured, crossing or interfering branches. In removing a branch, it should, in every instance, be cut back to a lateral, after which the cut should be painted with any ordinary paint. No stub should be left as this forms a means of entrance for wood rotting organisms.

Should strong vegetative growth arise from the interior of the tree, it should be removed at the point of origin.

Dead fruiting twigs will drop of their own accord, but, if present in abundance, it is advisable that they be removed.

Citrus pruning saws and hand shears are a necessity.

FERTILIZERS AND MANURES.

Throughout the citrus growing regions, difficulty is being experienced in maintaining soil fertility at a point where maximum production of fruit is secured. Everybody knows that continued cropping and cultivation of any soil will eventually lead to the depletion of the available plant food. The health and productivity of the trees themselves are the surest indications of soil fertility requirements.

In Fiji, where such a variety of soils are present, it is impossible to lay down any hard and fast manurial rules. The requirements of a sandy soil are by no means the same as those of a rich alluvial loam or a heavy clay soil. As we have no manurial experiment data in respect to citrus fruit production, we have to rely on what is used in other countries. In general these may be summarised as follows:—

Nitrogen proved to be the limiting plant food element. Groves receiving nitrogen showed an increase in production in direct proportion to the quantity of nitrogen applied up to a certain quantity. Half of the nitrogen was supplied by bulky organic manures.

Phosphoric acid or potash, used together or singly, gave no increase in tree health or fruit production.

It was doubtful whether phosphoric acid or potash used together with nitrogen gave any better results than when nitrogen alone was used.

DISEASES. [Insect pests]

Fiji is comparatively free from insect pests of citrus. The Red Scale, *Aspidiotus aurantii*, which is so difficult to control elsewhere, is absent, as also are the various citrus-feeding caterpillars which cause much trouble in some parts of the world.

The chief insect affecting the plant is a scale *Lepidosaphes beckii*, but this is seldom sufficiently abundant to cause much damage.

Of more importance are the insects attacking the ripe or nearly ripe fruits. The most notorious of these are the fruit flies, *Dacus passifloræ* and *Dacus xanthodes*, the latter always very scarce. These flies puncture the skin of the nearly ripe fruits and deposit a number of eggs in the cavity thus formed. These eggs hatch 48–96 hours later and the resulting maggots bore into the fruit, the tissues of which break down and rot. When full grown the maggot leaves the fruit (which generally falls to the ground prior to this) and enters the soil to pupate.

Control.—The pupæ seem to be susceptible to wet conditions and when a long spell of heavy rain coincides with the ripening of the fruit this pest becomes very scarce. In consequence of the presence of this pest, all fruit for export from Fiji is subject to a period of quarantine at the termination of which time it is repacked under Government supervision. The quarantine period allows time for the pest to develop and thus enables its presence to be detected.

Trapping.—A method of trapping Australian fruit flies has been evolved in Queensland, and recent trials of this bait have proved highly successful in Fiji. The trap is an ordinary glass fly trap baited with a liquid consisting of 1 tablespoonful Scrubb's Ammonia, 1 teaspoonful Essence of Vanilla and 1½ pints water. In two months six traps at Nasinu baited with this lure caught 82 male and 856 female adult fruit flies.

Fruit Piercing Moths.—Adult moths of the species *Ophideres fullonica*, and possibly some related kinds, pierce the ripening fruits to suck the juices, causing a breakdown of the tissues. The larvæ of this moth feed upon the coral tree *Erythrina corallodendron* and these should not be allowed to grow near citrus plantations.

Mealy Bugs.—These pests are sometimes present in small numbers. Whilst seldom sufficiently abundant to do direct damage they exude a honey-dew upon which a sooty mould grows and this does not improve the tree and may necessitate washing the fruit prior to shipment. Kerosene emulsion will control both this pest and the scale mentioned earlier.

HARVESTING.

Harvesting is by no means a simple matter. If possible, operations should be carried out in dry weather when the surface of the fruit is free from excessive dew or moisture. Should it be necessary to harvest during a wet spell, handling precautions must be doubled, as under such circumstances the skin is rendered more susceptible to skin abrasions and it is these abrasions that give rise to blue and green fungi in the fruit. In order that mechanical injury be minimised, the following points should be observed:—

The fruit should be cut from the tree with a short length of stalk attached; a second cut is then made as close to the button as possible. It is advisable to use clippers specially designed for this purpose.

Picking bags without sharp corners and capable of being opened at the bottom so that the fruit can be gently placed in the lug boxes should be used.

In order to avoid finger-nail scratches, pickers should wear gloves.

Lug boxes should be substantially made of planed wood.

The fruit should be conveyed from the grove to the packing sheds in well-sprung vehicles and, if the road be rough, a quantity of straw should be placed under the boxes.

Fruit should not be exposed to the sun for more than an hour.

Pickers should be instructed to handle the fruit so that thorn scratches, or bruises from any cause, are avoided.

When the fruit is conveyed to the packing station it should be placed in a cool, dry, well-ventilated room for about two days. This process is called "wilting" or "curing" and reduces the moisture content of the skin, thereby toughening it and rendering it less susceptible to injury during subsequent handlings.

Generally speaking, citrus fruits should be handled as carefully as eggs.

MARKETING OF FIJI BANANAS IN VANCOUVER.

As a result of conversations and correspondence with Mr. C. M. Croft, Canadian Trade Commissioner, Auckland, in 1930, a letter was addressed to His Majesty's Trade Commissioner, Vancouver, requesting information regarding Fiji produce which might find a market in Western Canada and the names of importing firms who might be interested in produce from this Colony. In the course of a detailed memorandum on the subject generally the Commissioner gave information about bananas and stated that Messrs. Robertson Company Limited would be glad to receive trial consignments. A number of letters passed on this and other subjects and in November, 1931, a bunch of bananas was despatched from Vancouver with the object of indicating the type and size of bunch and class of fruit which would be acceptable to the Vancouver market. The covering letter called attention to the Canadian duty of 50 cents. per bunch on bananas from all points outside the Empire and indicated the possibility of profitable trading between Fiji and Canada owing to the admission of bananas from Fiji free of duty. *Inter alia* it was stated that stems weighing not less than 50 lb were desired.

2. On December 29th, 1931, letters were addressed to the ten principal banana shippers in Fiji inviting their co-operation in a proposed trial shipment by the R.M.M.S. " Aorangi " sailing from Suva on the 15th January, 1932. The following particulars were given regarding the class of fruit required and the method of handling:—

Bunches should—

(*a*) be not less than 55 lb in weight;

(*b*) full three-quarter grade;

(*c*) clean and free from insect attack and bruising;

(*d*) wrapped in dried leaves prior to cutting and carefully cut and handled;

(*e*) not be left exposed to the sun in the field or during transit to Suva.

3. On the 5th January, 1932, Messrs. R. Robertson Company Limited were advised that a trial shipment would be forwarded by the steamer leaving on the 15th January and that this consignment would be sent forward in crates. It had previously been ascertained from the Shipping Company that the freight would be 80s. per 40 cubic feet or 4s. per bunch. The Company reserved one of the small refrigerator chambers for this shipment and undertook to maintain a temperature of 55°F. Unfortunately several of the banana exporters were unable to secure bunches of satisfactory quality, but from those submitted 151 stems averaging 58 lb were passed for shipment and duly forwarded. Details of weights were communicated to Messrs. R. Robertson Company Limited who were advised that some of the bunches had been slightly damaged before shipment and that the ends of all stems had been cleanly sawn off and dipped in molten paraffin wax.

4. The following are the marks, quantities and average weights of bananas supplied by individual shippers on this occasion:—

Name.	*Mark.*	*Crates.*	lb
Barber	B	25	60·6
Navuso	DA	2	53·0
Mrs. MacDonald	M	14	63·7
Freeman	F	10	56·8
Harinarain	HR	3	53·3
Wainimala Fruit Co. ..	WBC	9	61·2
L. F. Garnett	LFG	6	58·8
MacKenzie	TAV	21	62·0
J. A. Garnett	JAG	61	56·5

5. The Shipping Company were asked to reduce the freight from 80s. per ton to 4s. per bunch, *i.e.*, to regard the shipment as one of bunches rather than as one of crates. They replied that consideration would be given to this matter when the official returns were known, and it is satisfactory to record that the rate actually charged for this shipment was 3s. per bunch.

6. On the 31st January a cable was received from Messrs. R. Robertson Company Limited in the following terms:—

> " Condition good Garnett lot best quality can handle five hundred " Niagara " stored without crates temperature fifty-five degrees *stop*. Quote c.i.f. quality guaranteed Vancouver."

In reply to further inquiry a message arrived on the 2nd February stating that the bananas were in good condition, but too green for immediate sale. On the following day a message was received requesting that no shipment be made by the next steamer and stating that the fruit was not ripening normally, possibly owing to " chilling."

7. The District Fruit Inspector of the Canadian Department of Agriculture reported to the consignees on February 2nd in the following terms:—

> " Inspector Wm. J. Coell reports that he looked at these bananas about 8.30 a.m. on January 30th in the banana room of F. R. Stewart's warehouse. The bananas had been taken from the crates and strung up. Temperature of the room was around seventy degrees with plenty of moisture. The general appearance of the fruit was good, mostly green with approximately eight stems fairly yellow, nine stems turning, balance green. Fruit appeared well matured and plump, but showed considerable bruising and what was apparently sucking insect injury. This fruit was again looked at this morning. Apart from a few stems that are turning with a healthy colour, the balance has a general appearance of having been chilled. The ripe and turning fruit appear lifeless, and the bruising has decayed and shows mildew. The majority are still very green and are ripening slowly. Temperature of room was seventy-five with plenty of moisture."

8. That firm telegraphed on the 20th February as follows:—

> " Bananas.—Owing condition net returns 188 dollars, including drawback duty. Until ventilated refrigeration available fear cannot depend satisfactory arrival."

At the current rate of exchange the sum quoted was £66 13s. 0d. or 6s. 2d. a bunch, a rather disappointing result. However, the shipment was purely of an experimental nature and useful lessons were learned from it which assisted greatly in controlling the subsequent experimental shipments described below.

9. It was unfortunate that the fruit was discharged at Vancouver during a period of exceptionally cold weather and the fact that three hours elapsed between the time of discharge from the steamer and entry to the ripening room may have given rise to the condition caused by chilling referred to in the reports quoted above. It has not been possible to say definitely whether the chilled condition arose through exposure to too low a temperature in the ship or to the low temperature prevailing at Vancouver at the time of arrival. In further correspondence from the consignees it was stated that the ship's records show that the fruit had been carried at the correct temperature, but there was still some doubt as to when the chilling occurred.

10. The firm indicated its desire to see a development of the banana trade between Fiji and Vancouver and offered to co-operate in every possible way if future experiments were decided upon. Owing to the condition of the fruit and the irregular manner in which it ripened, it had to be sold as a job lot and detailed returns to the different participating shippers could not be given.

11. The following conclusions were arrived at as a result of the observations made in respect of this trial:—

(*a*) that considerably greater care was necessary in handling the fruit in Fiji;

(*b*) that a slightly higher temperature in the ship's cooling room was desirable;

(*c*) that careful control of ventilation was necessary;

(*d*) that the cost of crates with additional shipping charges incurred by their use made it impossible profitably to ship bananas in that manner;

(*e*) that for successful commercial shipments the fruit should be grown as near as possible to Suva in order to minimise pre-shipment damage.

12. On the occasion of the visit of the Director of Agriculture to New Zealand in March, 1932, the subject of export of bananas from Fiji to Vancouver was discussed with the Manager of the Union Steam Ship Company, Wellington. The Company undertook to co-operate in a series of of four experimental shipments to commence in May, 1932. Messrs. R. Robertson Company Limited were duly informed and the co-operation of shippers in Fiji was sought. It was felt that the arrival of these consignments during the spring and summer in Vancouver would provide much better conditions under which to examine the suitability of Fiji bananas for the Vancouver market. It was hoped that the consignments would approximate 500 bunches on each occasion, but owing to a variety of causes, among which was the uncertainty of profitable returns, this number was never reached. Consultation took place between Messrs. R. Robertson Company Limited and the officers of the ships which were to carry the fruit, and it is highly gratifying to record that those officers took a keen interest in the course of the experiments and did everything in their power to ensure success.

13. Circulars were issued to fruit shippers on April 19th, 1932 (Appendix I) and June 16th, 1932 (Appendix II) giving information and directions regarding the shipments.

14. The first consignment in this series, consisting of 270 bunches, was shipped by the "Aorangi" on May 6th. On this occasion the co-operation of the Canadian Government Fruit Inspector was sought in a letter addressed

to him by the mail leaving that day. Subsequent shipments were as follows:—

Date.	*Vessel.*	*Quantity.*
3 June	"Niagara"	189 bunches.
1 July	"Aorangi"	123 ,,
29 July	"Niagara"	91 ,,

15. Commenting on the first of these shipments Messrs. R. Robertson Company Limited stated that many of the bananas were more or less bruised, apparently owing to rough handling prior to shipment. The bruising showed up as the fruit ripened and the colour developed. It was remarked that the worst fault was that the bananas did not show the clean, bright colour when ripe as was the case with the class of fruit to which Vancouver consumers are accustomed. Attention was called to the necessity of leaving three or four inches of the small end of the stem in order to facilitate handling and to enable the fruit to be properly hung in the ripening room.

16. The quality of the flesh of the fruit was reported as being "more palatable, and better and nicer to eat in every way than Central American bananas." It was stated that with careful handling there were possibilities of the development of quite a large business in bananas from Fiji. A letter written two days later indicated that as the fruit ripened, bad scars appeared, evidently caused by rough handling while the bananas were green. Reference was again made to the excellent chances of developing trade provided the outward appearance of the fruit were improved.

17. The Fruit Inspector reported that 28 bunches of the consignment arrived ripe and were sold immediately, 12 bunches were turning and the balance was green. There was no apparent chilling. Attention was drawn to the presence of two types of fruit. These were described as:—

(1) a long fruit with decided ribs or corners (Veimama);

(2) a shorter fruit which was more round and plump (Cavendish).

The report went on to say that No. 1 type ripened more evenly with a much cleaner skin similar to the Central American banana, while No. 2 showed evidence of bruising and discolouration with brown spots which appeared on the skin before the fruit had ripened.

18. The District Fruit and Vegetable Inspector reporting on the shipment which left Suva by the "Niagara" on the 3rd June, 1932, said that the stems were well stowed with excelsior (wood-wool) as dunnage between the bunches. The temperature of the room and fruit on arrival was 52°F. The fruit was generally green but dull and apparently chilled. During ripening the fruit changed colour very slowly and developed the "flat" appearance indicative of chilling during transit. Scarring became more and more apparent as the fruit ripened and seriously affected its appearance. It was suggested that a trial should be made at a slightly higher temperature. Mr. C. M. Croft who was travelling by the same steamer was accorded facilities by Messrs. R. Robertson Company Limited for observing the condition of the fruit on arrival.

19. Captain Hill of the "Niagara" furnished a report on this shipment and again called attention to the excellent texture and flavour but poor appearance owing to bruising and skin marking. He said that the temperature was 53°F. which is the lowest temperature to which bananas should be subjected. Two bunches were given to the General Manager of the Canadian Australian Line and the fruit was distributed amongst members of the Vancouver Club. Captain Hill brought back with him a bunch of

Honolulu bananas to show the method of protection adopted for that fruit. He said that there was not the slightest doubt that a good market for Fiji bananas could be developed in Vancouver during the Canadian summer, but that growers must supervise their shipments more closely and see that rough handling was entirely avoided.

20. Mr. C. M. Croft in a letter dated July 5th gave valuable independent observations on this shipment. He was given facilities while on board for examining the fruit during transit and was assured that the temperature never went below 53°F. during the voyage. He described the appearance of the fruit on ripening as "flat" and remarked that this was greatly against the Fiji fruit as bananas from Central America presented a very bright appearance and were altogether attractive, whereas Fiji bananas would not appeal particularly to the eye. The opinion was, however, again expressed that the flavour of the Fiji bananas was very much superior to other bananas on the Vancouver market. Reference was made to the blemishes on the surface and to the fact that this would detract from ready sale of the fruit, as well as to other points which have already been dealt with, and Mr. Croft went on to say:—

> "It would seem that this report has been entirely unfavourable, but I can assure you that the fruit merchants in Vancouver are delighted with the flavour of the Fiji banana, and would certainly like to see the fruit arrive in as good a condition as that from Central America and other countries. They intimate that if this could be done they feel sure that you will be able to secure a very large proportion of the business offering in British Columbia. I realise that I have offered criticisms all the way through, but I have not suggested any remedies. I appreciate the fact that the bananas must be moderately well advanced before shipment, but on the other hand they must not ripen before arrival. The shipment by the "Niaraga" was just beginning to ripen and was considered to be in excellent condition so far as ripeness was concerned when it reached Canada. This brings up the question as to whether or not a higher temperature which might prevent chilling would not result in the bananas ripening *en route*. The Fruit Inspector suggested that it might be advisable to try a small shipment at a temperature of say 56, to ascertain whether or not this would permit of the desired feature of the prevention of chilling and still maintain the degree of ripeness necessary."

21. A letter enclosing account sales and remittance for this shipment contained a statement to the effect that the fruit had not matured at all well, the skins turning black as the bananas ripened. Sales were thereby rendered very difficult.

22. A request was made for later shipments to be carried at a temperature between 55–60°F. and as a result a better out-turn was obtained, although the skin marking and bruising was still present.

23. The "Aorangi" shipment of July 1st was carried at a temperature of 54°F. according to a report received from the District Fruit and Vegetable Inspector, Vancouver. An hour after unloading the temperature of the fruit was 56·5°F. the temperature of the dock being 57·5°F. The appearance and condition of the fruit showed an improvement over earlier shipments. The bananas were generally plump, well filled and of a brighter colour. Of the 123 stems, four were fully ripe, eight ripe, seven turning and the balance green. The green bananas on breaking exuded sap in contradistinction to the fruit carried on earlier shipments. This was an indication that chilling had been avoided.

24. The last shipment in the series by the "Niagara" was the subject of a detailed report by the District Fruit and Vegetable Inspector. Mr. G. K. Roth, District Commissioner, who travelled by the same vessel was able to see the fruit on arrival. He found several of the bunches very badly bruised and others somewhat marked with scab. Although informed that the shipment was the best that had so far arrived he was very disappointed with it. In commenting upon the requirements of the Vancouver market he said that larger stems of an average weight of about 50 pounds were desired. The fruit is expected under normal circumstances to ripen in about four days after arrival, but the Fiji fruit did not ripen normally and took a week or more before it was fit for sale. During this period it developed the bruised and marked appearance already referred to. Bunches are handled with the greatest care and when transported are laid on straw or padded sacking in order to prevent rubbing and bruising. Reference was made to the method of testing and to the apparent chilling of fruit in some of the earlier shipments. Mr. Roth's report contained considerable detail, part of which has been summarised above. The following quotation is taken direct from the letter received from him:—

"As far as we could decipher the red numbers on the stems of fruit, the following were the numbers of bunches showing bruises or scab or both:—

No. 2—full size fruit but bruised;
No. 8—bruised;
No. 7—(two bunches) one with scab, one with very bad bruises;
No. 5—scab;
No. 11—one bunch scab and badly rubbed, one bunch good size fruit and suitable;
No. 12—one bunch bruised and scab, but good size fruit, one bunch bruised;
No. 16—one bunch small size fruit, one bunch scab;
No. 17—bruised.

It should be repeated that the above numbers are the red numbers painted on the stems and not the number of bunches.

Size.—Larger bunches are appreciated. Of those sent in this shipment very many are of only about 30 lb weight whereas bunches of 50 lb would be better. This size (50 lb) is the size of the other bananas sold here (see later). There is also a good deal of uneveness of size of fruit. When the fruit is brought in to the importers here they hang it up in a room at a temperature of 70°.

Ripening.—In this room the fruit is expected to ripen in about four days, but some of the Fiji fruit does not ripen for a week, and when ripe does not present at all an attractive appearance, being discoloured by bruises and scab and rubbing. It is believed here that this slowness on the part of our fruit to ripen as described is due to the cool temperature at which it is kept on the ship. This temperature is, I believe, 53 to 56°, whereas the fruit from elsewhere is kept at about 58 to 60°. The fruit at this end is handled as if it were a baby. In the vans which bring it up from the wharf to the importers' sheds there is straw or sacking on the bottom of the vans; and on the handcarts taking it from the van to the ripening room there are padded sacks and, as I say, the men handling each bunch take each bunch up as a woman might take her baby. The bruises in our fruit, judging it from the appearance at this end, are, in my view, due to the fruit being dumped on to a hard surface like a pebbly beach or a 'bilibili,' or a punt or a wharf."

25. The main conclusion arrived at is that a ready market at satisfactory prices awaits supplies of Fiji bananas in Vancouver, provided that the fruit can be landed in a condition comparable with Central American bananas, *i.e.*, free from blemishes and skin markings. The gradual improvement noticed in successive shipments during the trials was encouraging, but the unsatisfactory appearance on ripening was still evident. The conclusions recorded at (*a*) and (*e*) of paragraph 11 were confirmed.

26. The conditions necessary for successful marketing of bananas in Vancouver may be summarised thus:—

(*a*) the Gros Michel and Veimama varieties only should be shipped;
(*b*) stems or bunches should be green and well developed, and weigh approximately 50 lb;
(*c*) crates should be used to convey the fruit from the plant to the ship's side, dry leaves, grass, "wood wool," or similar material being used to prevent damage in transit;
(*d*) a few inches of the small end of the stem should be left to facilitate handling;
(*e*) the period elapsing between cutting and shipment should be as short as possible;
(*f*) the fruit should be cut in fine weather and should be free from surface moisture;
(*g*) the ends of the stem should be cut cleanly and coated with petroleum jelly or molten paraffin wax as soon as the sap has ceased to exude;
(*h*) the fruit should be carried at a temperature not below 55°F.

27. The financial results of these trial shipments are given in Appendix III.

I desire to express my thanks to all those individuals and firms, many of whom are mentioned in this report, who co-operated in various ways in these trial shipments.

APPENDIX I.

TRIAL SHIPMENTS OF BANANAS TO VANCOUVER.

1. The Union Steamship Company Limited on behalf of the Canadian-Australian Line have undertaken to co-operate with the Department of Agriculture in four trial shipments of bananas to Vancouver, each of 500 bunches, commencing with the "Aorangi" scheduled to leave Suva on May 6th, 1932.

2. It will be recollected that 151 bunches were forwarded to Vancouver in January, 1932, but although the fruit arrived in apparently good condition, it did not ripen normally, and the prices realised were not satisfactory. Further information is awaited before a final report on that trial can be issued, but the returns will allow payment at the rate of two shillings net per bunch to shippers.

3. The prospects for bananas which arrive in Vancouver during the Spring and Summer are good. Arrangements have been made for the consignment to be carried under the best conditions possible, and to be received, inspected and sold to the best advantage.

4. The depressed state of the New Zealand market and the increased local production render it essential to explore the possibilities of the Western Canadian market, where bananas from Fiji enjoy a tariff preference of half a dollar a bunch over non-Empire fruit, and British West Indian fruit transported through U.S.A. territory.

5. The principal difficulties in connection with successful shipments will occur in Fiji owing to careless and improper methods of handling the bunches, but it is felt that growers and shippers will use their best endeavours to secure the shipment of the fruit in prime condition. Attention is therefore requested to the following directions:—

(*a*) bunches should be of eight hands or over of full three-quarter grade;
(*b*) fruit must be clean, free from blemish and unbruised;
(*c*) fruit affected by the "leaf-spot" condition will not be accepted;
(*d*) bunches should be cut in dry weather, and carefully protected from rain and sun;
(*e*) during transit the bunches should be stowed stem down, and prevented from rubbing by dry banana leaves or other suitable material;
(*f*) the fruit must be delivered to the Inspector of Produce before 10 a.m. on May 5th, so that any bunches unsuitable for Vancouver may be sent, if satisfactory, to Auckland;
(*g*) all bunches should bear a mark to indicate the place where they were grown, as well as the mark of the shipper.

6. It will be observed that no stipulation regarding weight has been made. Though there has been no change in the instructions from Vancouver, it is felt that a number of bunches less than 50 lb in weight should be forwarded on this occasion. Bunches will be shipped loose, with "wood-wool" packing in the cool room.

8. Those persons who wish to participate in these shipments are requested to inform the undersigned on or before April 29th stating the number of bunches they expect to supply for the first shipment. Particulars regarding subsequent shipments should be sent in so as to reach this office seven days or more before the date of sailing of the ship.

You are reminded that the next shipment will be made on 6th May, 1932.

A. C. Barnes,
Director of Agriculture.

Suva, 19th April, 1932.

APPENDIX II.

TRIAL SHIPMENTS OF BANANAS TO VANCOUVER.

Your attention is called to the circular issued on April 19th, 1932, a copy of which is enclosed. In that circular your co-operation was sought in connection with investigations of banana markets in Vancouver.

2. Two shipments of a series of four have already gone forward, but in both instances the number of bunches supplied has fallen considerably short of the capacity of the space arranged for. In May 270 and in June 189 bunches were forwarded. A report has been received in regard to the first of these shipments, indicating that there has been considerable damage by bruising prior to shipment. Damage of this nature becomes increasingly evident as the fruit ripens, although it may hardly be observable when the fruit is green. The texture and flavour of the flesh are regarded as superior, and the opinion was expressed that Fiji bananas should be able to commend a ready market in Vancouver, provided the appearance of the ripe fruit could be improved.

3. Although the necessity for the most careful handling has been urged, it is evident that shippers and those employed by them have not paid sufficient attention to this matter. In the circular referred to a series of precautions is given in paragraph 5. It is requested that the precautions outlined there be fully observed and that every endeavour be made from the time the fruit

leaves the tree until it arrives alongside the steamer to reduce damage to the absolute minimum. It is recommended that crates, open at the top and about three feet long and eighteen inches square at the ends be used for carrying the fruit at all stages. The bunches should be laid with trash, grass or other suitable dry material in the crates immediately they are cut from the trees and should not be taken out by the shipper. Any subsequent handling required after arrival at the wharf will be done under the supervision of Fruit Inspectors.

4. Where it is not possible to use crates the direction at 5 (*e*) should be carefully observed. Vancouver consignees also ask that a portion of the stem about six inches long may be left at the upper end of the bunch, that is to say, the lower end as the bunch hangs from the tree. The object of this is to enable the bunch to be readily handled and hung in the ripening rooms.

5. It is requested that early application be made for space for the next shipment which is due to leave Suva on the 1st July, 1932.

" Waipahi " shipment, June 30th.—Growers and shippers are hereby notified that there will be no variation to the existing regulations regarding the shipment of bananas by the " Waipahi " sailing from Suva on June 30th.

A. C. BARNES,
Director of Agriculture.

Suva, 16th June, 1932.

APPENDIX III.

ACCOUNT SALES FOR FIVE SHIPMENTS OF BANANAS TO VANCOUVER DURING THE YEAR 1932.

First shipment.—15/1/32, R.M.M.S. "Aorangi ":—

151 crated stems bananas realised at Vancouver			£46 13 6
Plus exchange at Suva			1 18 8
			48 12 2
Less—Charges—			
Freight to Vancouver at 3s. per crate	£22 13 0		
Cost of crates at 2s. 6d. each	18 17 6		
Cartage at Suva Wharf	1 5 2		
Cables to Vancouver	1 1 0		
Labour and packing at 6d. per crate	3 15 6		
		47 12 2	
Nett return		£1 0 0	

Second shipment (first of four trials).—6/5/32, R.M.M.S. "Aorangi ":—

270 stems bananas (freight to Vancouver paid at destination) realised at Vancouver		£29 3 3
Plus exchange at Suva		3 2 3
		32 5 6
Less—Cartage at Suva wharf		0 16 11
Nett return		£31 8 7

Third shipment (second of four trials).—3/6/32, R.M.M.S. "Niagara":—

185 stems bananas realised at Vancouver			£33 1 11
Plus exchange at Suva			3 4 4
			36 6 3
Less—Freight to Vancouver paid in Suva	£37 16 0		
Cartage at Suva wharf	0 11 10		
			38 7 10
Nett loss			£2 1 7

Fourth shipment (third of four trials).—1/7/32, R.M.M.S. "Aorangi":—

123 stems bananas realised at Vancouver			£28 14 0
Plus exchange at Suva			2 15 7
			31 9 7
Less—Freight to Vancouver at 4s. paid in Suva..	£24 12 0		
Cartage at Suva wharf	0 7 8		
			24 19 8
Nett return			£6 9 11

Fifth shipment (last of four trials).—29/7/32, R.M.M.S. "Niagara":—

91 stems bananas realised at Vancouver			£31 13 7
Plus exchange at Suva			3 1 6
			34 15 1
Less—Freight to Vancouver paid in Suva at 4s. ..	£18 4 0		
Cartage at Suva wharf	0 16 0		
			19 0 0
Nett return			£15 15 1

SUMMARY OF SHIPMENTS.

SHOWING NETT AMOUNT AVAILABLE FOR DISBURSEMENT TO SUPPLIERS OF FRUIT AVERAGED OVER FIVE SHIPMENTS.

1st	shipment	(151 crates)	£1 0 0	
2nd	,,	(270 stems)	31 8 7	
4th	,,	(123 stems)	6 9 11	
5th	,,	(91 stems)	15 15 1	
			54 13 7	
3rd	,,	(185 stems) Net loss	2 1 7	
Total stems 820			52 12 0	
Plus—Proportion of costs of initial shipment of 151 crates			23 14 0*	
			£76 6 0	

Average return per stem = 1s. 10½d.

* As the initial shipment of 151 crated bunches was in the nature of an experiment, the costs of crates (£18 17s. 6d.), cables (£1), and labour and packing (£3 15s. 6d.) were met from Departmental funds.

THE DRYING OF COPRA: THE "INCLINED CHAMBER" COPRA DRIER.

By A. C. Barnes, F.I.C., B.Sc., A.M.I.Ch.E., Director of Agriculture.

Investigations on the drying of copra have been continued for some time with the objects of improving the types of artificial driers now in use in Fiji and devising a drier suitable for use by Fijian communities that own moderately large areas of bearing coconuts. The problem in Fiji is not so much to find a satisfactory type of small drier with a capacity of but a few bags, as is the case in copra-producing countries where considerations relating to individual small producers apply, as to find a standard design suitable for erection in a range of sizes. The Fijians are accustomed to deal with most of their affairs on a communal basis and copra production has not yet generally reached the stage of purely individual effort, in so far as the Fijian's share of the industry is concerned. There are certain districts where a small type of drier with an output of the order of 5 cwt. of dried copra per diem could be introcuced with advantage and this aspect of the problem, though not lost sight of, cannot receive adequate attention until a sufficient number of trained Fijian youths are available for instructional work amongst their own people with but occasional supervision by a travelling European officer.

2. In the first instance, therefore, attention has been given to the design of a drier of what one may term "plantation capacity" suitable either for European or native use. It may be taken that the general requirements for both classes of user are the same and they that include:—

(*a*) freedom from risk of fire;
(*b*) economic fuel consumption;
(*c*) heat conservation;
(*d*) uniform heating of the drying current;
(*e*) satisfactory control of air currents and temperature;
(*f*) ease and simplicity of charging and discharging arrangements;
(*g*) provision for variation of charge;
(*h*) general simplicity of operation with a view to reduction of supervising costs;
(*i*) cheapness of construction;
(*j*) use of standardised parts in construction;
(*k*) freedom from mechanical devices.

3. In a paper read at a Conference of the Institution of Chemical Engineers on December 7th, 1928, the writer dealt in brief with some of the points which should be observed in the design and construction of driers for tropical products (*Transactions of the Institution of Chemical Engineers*, 1928, page 177). Dealing with the subject of copra driers the writer pointed out that in Zanzibar, as in some other copra-producing countries, a very simple type of drier consisting of a crude platform of branches and sticks with a fire of husks underneath is used. It is curious that the Fijians appear never to have attempted to make for themselves an artificial drier even of such simple construction as that.

4. I quote in detail from the paper under reference:—

> "It will be realised that the matter of designing driers for the small producer must to a great extent be investigated on the spot, by people with an intimate knowledge of local conditions and the ability to utilise material readily available. Some of these materials will necessarily have to be imported; and although British manufacturers would

GENERAL VIEW, SHOWING COPRA DRIER AND PART OF NATIVE TOWN.

COPRA DRIER, LOADING SIDE.

undoubtedly prefer to sell complete plants, they should not lose sight of the demand for parts to be used in the construction of dryers in the Colonies. Examples of such are sections for the framework of sliding and adjustable roofs for open air drying grounds; metal drying trays, both complete and in parts, of different sizes of frame and mesh suited to the material to be dried; furnace fronts and doors to be set in masonry; iron flues with fins to increase radiation of heat; smoke boxes and iron chimneys. It may be thought that the problem as presented is not within the scope of the functions of such an Institution as ours; but there is a genuine demand for standard designs of driers which can be constructed mainly from local materials and partly from imported sections. Though various types of simple drier have been in use for many years, and the principles of hot air drying are well known, there is still much room for improvement.

Generally, fuel requirements for artificial drying are readily met on the spot. Waste products from the raw material to be dried are often available in more than sufficient quantity. Thus, palm nut shell, and the husk and shell of the coconut provide excellent fuel. In spite of this, however, heating efficiency must not be too heavily sacrificed for simplicity."

The points there referred to have been borne in mind in connection with the investigations which are now in progress and it will be observed that imported standard drier parts have been largely used in the construction of the plant.

5. In Fiji there are not less than 30 artificial copra driers of a diversity of design. Many of these have been inspected and conclusions arrived at regarding their relative efficiency. In 1930 the writer visited Western Samoa with the object of ascertaining from personal examination the suitability of types of copra driers in use there for adoption in Fiji. A report was published in *Agricultural Journal* No. 3 of 1930. On this occasion I was much impressed by the simplicity, cheapness of construction and ease of working of what I called the "inclined chamber drier," and I recommended that the Coconut Committee of Fiji should bear the cost of erection of a drier of similar design at a selected place in Fiji, and that the installation should be used in the first instance for experimental observations on the hot air drying of copra. The Committee approved of this proposal and a drier was designed in consultation with the Commissioner of Works.

6. The drier, which is housed in a galvanized iron shed with open sides, consists of three essential parts—(1) the furnace and air heating system; (2) the hot air mixing and regulating chamber and (3) copra drying chambers. Apart from a wide departure from the conventional design of copra driers in Fiji the provision of the hot air mixing and regulating chamber is a further difference from most existing driers. In the usual type the air is heated by pipes set in the upper part of the furnace and led direct to the lower part of the drying chamber, air vents being provided either by additional unheated pipes or by apertures in the lower part of the chamber wall. Another detail to which attention has been given is the provision of what has been called a precipitating chamber beyond the actual furnace in which combustion can be completed with consequent protection from rapid corrosion of the heating flue at its hottest part.

7. The furnace and hot air regulating chamber are built on a 4-inch concrete foundation, the surface of which is 4 feet below ground level. The fire-box and precipitating chamber lead to the direct heating flue 12 inches

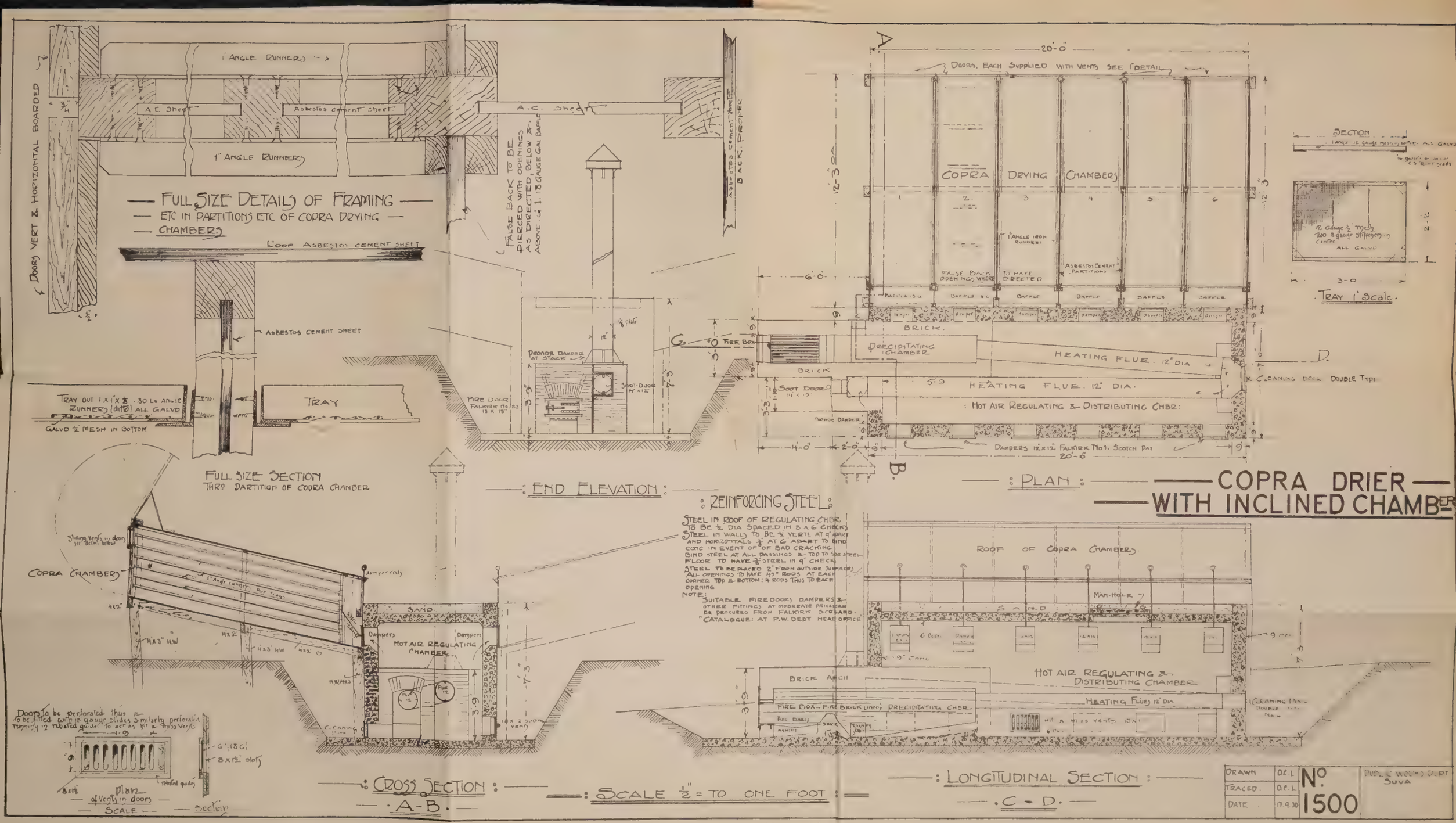
in diameter and thence to the return heating flue of the same size which gives access to the chimney set on a pedestal by the side of the fire-box and outside the hot air regulating chamber. About two-thirds of the precipitating chamber and the whole length of the heating flues are inside the large chamber. Inspection and cleaning doors are provided to the precipitating chamber, flues, and chimney base. The hot air regulating and distributing chamber is constructed of concrete 19 ft. 6 in. long, 6 ft. wide and 6 ft. high, internal dimensions. The actual capacity of this chamber after deduction of the space occupied by the precipitating chamber, heating flues and brick work support for the flue junction is 600 cubic feet.

8. The supply of cool air is admitted through cast iron sliding vents set in the concrete in the lower part of the chamber walls. There are ten of these 18 in. by 10 in. over all, each with a cool air admission space of 50 square inches. In the upper part of the side walls of the chamber are apertures 12 in. by 12 in. fitted with adjustable dampers. Six of these have been placed on each side though only one set is at present in use as only one wing of the drier has been constructed. It should be observed here that the design provides for the addition of another chamber, thus doubling the capacity. The roof of the chamber is 6 in. in thickness and it is covered with a 6 in. layer of sand, in order to cheapen construction, and to conserve heat. A large man-hole with a movable cover is provided, giving ready access to the interior of the chamber for inspection of the heating arrangements.

9. The drying chamber is inclined and built at one side of the hot air regulating chamber. It consists of six separate compartments each of which is fed by hot air from one of the controlled hot air apertures already referred to. The drying chamber is constructed of a wood frame work with half-inch cement asbestos-sheets, thus combining cheapness of construction with protection against fire. Each compartment is fitted with a door hinged at the top and adjustable vents are attached to each door. The compartments have six angle iron runners on each side spaced at 6 in. intervals for carrying trays of copra to be dried.

10. The trays themselves are 3 ft. by 2 ft. 2 in. with angle iron frames and half inch 12-gauge mesh bottoms. The corners are strengthened with angle plates and the sides are 2 in. high. The more distant trays are fed into the compartments and removed therefrom by a long pole with a hook at the end.

11. At the end of each compartment next to the hot air regulating chamber is a small space separated from the main compartment by a sheet of asbestos-cement having longitudinal slits, each slit corresponding to the part immediately below the line of trays. A baffle from the middle of the hot air aperture to this partition separates the hot air current into two parts when the damper is fully opened and as the third line of runners carries a sheet of asbestos-cement for its whole length, every compartment is in effect again sub-divided into an upper and lower section, each independently supplied with hot air. As a general rule the runners carrying the partition are not loaded with copra trays, but it would be possible to increase the capacity of the drier by using trays with imperforated bottoms in place of the divisional sheet of fibrolite. Without this provision the capacity of the one wing as now constructed is 4,500 lb of green copra carried on 150 trays, 30 pounds to each tray. With the modification mentioned above the capacity would be 5,400 pounds of green copra.



NOTE.—All scales reduced one half by reproduction.

12. It is not claimed that this design completely satisfies the conditions set out in paragraph 2, but it does possess the advantage of being readily and cheaply adaptable within limits in the light of experience gained of its working. It will be observed that very little timber is used in the construction of the drying chamber, which again is set to the side of the hot air regulating chamber so that the risk of fire to any part of the actual structure is remote. A more expensive structural design using mild steel sections in place of the timber, coupled with asbestos-cement in metal frames for the doors would have resulted in a structure entirely constructed of non-inflammable material. However, it may fairly be claimed that the design combines a satisfactory degree of fireproofness with cheapness of construction.

13. The greatest risk of fire in any drier of the hot air type is the accidental ignition of the copra when it is almost ready to leave the chamber. Accidents of this nature are usually the result of some serious fault in the heating system; and driers which have chambers directly set above the furnace and heating flues are particularly liable to the risk of fire, as also are those which are fed with hot air by pipes set in the furnace. In the latter case fire occasionally occurs either by a breakdown of the masonry in which the heating pipes are set, allowing the fire to obtain direct access to the drying chamber, or by corrosion of the pipes by the products of combustion followed by breakdown of the pipe wall, with a similar result.

14. Apart from fire-proof construction of the actual drier it is necessary to reduce to an absolute minimum the risk of pieces of dried copra becoming ignited either by falling upon very hot pipes or by the access of flame from the furnace. The design described provides for a small space at the inner end of each chamber, separated from the part carrying the trays of copra by a false back with openings to permit the ingress of hot air. It is in this small section of each compartment that the baffle already described is situated. As well as securing a more even distribution of hot air to the upper and lower parts of each compartment this small sub-division prevents pieces of copra falling from the trays and slipping through the damper openings into the hot air regulating and distributing chamber.

15. There is, however, still another advantage in that if by accident combustible material were fired in any part of the hot air regulating chamber or any copra drying compartment, that part could be isolated immediately by closing the hot air dampers, and the fire extinguished by completely closing all apertures, thus shutting off the supply of air. Inspection of the plan will make this statement clear. For a fire to occur a breakdown of part of the furnace, heating flue, or flue settings would first be necessary, and for copra drying in one or other of the chambers to be subjected to a sufficiently high temperature to ignite it. A breakdown in any of the heating arrangements would immediately become apparent by the issue of smoke and fumes from the doors of the drier compartments. On seeing this the the attendant would close all dampers and all vents both to the air regulating chamber and to the drying compartments and then draw the fire. Only under very exceptional circumstances, with gross carelessness on the part of the attendant, would serious damage be likely to occur.

16. The questions of economic fuel consumption and heat conservation have been dealt with in the design of the furnace and air heating arrangements, by the provision of a hot air regulating and distributing chamber with a number of easily controllable cold air ingress and hot air egress vents as well as by dividing the main drying chamber into a series of compartments, each of which can be operated independently of any of the others. It was

at first thought that the use of cement-asbestos sheeting half an inch thick for the outer walls of the drying chamber would satisfactorily reduce loss of heat by convection and radiation. It has, however, been found in practice that the loss of heat from the outside of the drying chamber is serious, and experimental work has been undertaken with the object of devising a cheap form of heat insulation which will reduce such loss to a minimum. Two compartments were selected for special treatment. No. 2 was covered on the top and at the bottom with the proprietary material known as Gyproc, $\frac{3}{8}$ in. thick. This material consists of gypsum between paper walls and is sold in sheets of various sizes and thicknesses. Chamber No. 4 was covered at the top and the bottom with a 3-inch layer of dried Insulex, a mixture of short fibre asbestos and powdered gypsum, kept in position by sheets of Gyproc of the same thickness as that used for chamber No. 2.

17. Observations have been made of the surface temperature of the compartments covered with (*a*) asbestos-cement only, (*b*) Gyproc only and (*c*) insulated as described. The rise of temperature of the outside surface of the insulated compartment was very small during a period of 24 hours when copra was being dried and when the maximum temperature reached inside was 103° C. The highest surface temperature recorded on chamber No. 4 was 43° C., whereas there was no appreciable difference between the surface temperature of the compartment treated with Gyproc and those covered only with asbestos-cement. In those cases the surface reached a temperature of 61·5° C. within three hours after charging. It is therefore proposed to insulate the whole of the copra drying chamber with three inches depth of Insulex at the top, bottom and sides, covered with $\frac{3}{8}$ in. Gyproc sheeting.

18. Uniform heating and satisfactory control of hot air currents are perhaps the most difficult problems in connection with copra drier construction of the type under consideration. The necessity for avoidance of mechanical complications, particularly power driven fans, makes it necessary to incorporate in the design provision for natural movement of currents of air under the influence of difference of temperature. The only contrivances which under these conditions can be used in controlling the direction of air currents are deflection or baffle plates and suitably placed dampers. The chamber design and the arrangement of trays carrying copra must receive careful attention in relation to the direction of movement of hot air currents and to the elimination of dead spots where little or no movement of air over the copra to be dried occurs. The provision of the hot air regulating and distributing chamber with cold air vents at the bottom and hot air vents at the top of the walls provides a reasonably efficient, uniform air heating arrangement, while the adjustable dampers both for cold and hot air and the sliding vents in the doors of the drying compartments, together with the subdivisional partition in each compartment ensures control and proper distribution of hot air.

19. In practice it has been found that although the drying of the copra is not entirely uniform in the early stages it is possible without any difficulty to secure a uniform product by individual control of the compartments towards the end of the drying period. As would be expected chambers Nos. *1 and 2 which are fed with air directly heated by the walls of the furnace combustion chamber tend, under normal conditions, to attain a somewhat higher temperature than chambers Nos. 5 and 6, but with modified tempera-

* For convenience of reference the compartments are numbered 1—6, commencing at the furnace end of the drier.

ture control in such a manner that the hot air supply can be cut off in the same proportion from the upper and lower halves of the chamber it would be possible to compensate for this difference. The dampers as at present used when fully open supply hot air in equal quantity to the upper and lower halves of each compartment but when partially closed the supply is cut off from the upper subdivision only and although in practice this arrangement has been found satisfactory it is considered that a modified damper design would be better.

20. As at present erected the cold air vents are sufficient for one wing, but if another wing were to be added it would be necessary to increase the provision for admission of cold air. Although the actual wall apertures are 18 in. by 12 in. the effective aperture in each case is only 50 square inches owing to the design of the " hit and miss " dampers. It would be a simple matter to remove the present cold air dampers entirely and replace them with sliding doors which would quadruple the total apertures available for cold air admission.

21. A wooden platform is erected in front of the drier to facilitate charging and discharging. The trays are of strong construction, but are easily handled both when full and empty, sliding freely along the rails provided inside the drying compartments. Working all chambers the drier is discharged completely and recharged in less than an hour. If a full charge is not available, two methods of working present themselves:—either one or more chambers are not used at all and are cut off the hot air supply, or the copra is divided uniformly on trays put in all chambers. Once the drier is charged the copra is not moved until drying is completed, in contrast with the practice with some driers of the horizontal type where trays of partially dried copra are moved along at intervals to hotter parts of the drier, other trays of completely dried copra being removed and still others of undried material inserted. The principal disadvantages of this practice are the increased handling and loss of heat with consequent lower fuel economy.

22. Under working conditions the drier is filled by the owners of the copra in the afternoon of one day and discharged by the same people the following afternoon, 22 or 23 hours later. During the drying period one fireman only is required at a time who with experience would be able to attend to all controls. While experimental work is in progress a European officer is in charge, but a Fijian has been trained and is now capable of working the drier under normal conditions, and of keeping essential records.

23. The drier was first put into operation on the 7th March, 1932. It was unfortunate that the full number of trays was not supplied at the outset, 30 only being ordered. The trays available were used in various ways, distributed throughout the compartments or confined to one or two compartments only. In order to cope with the demands made upon the drier, copra had to be loaded on to the floors and central partitions of the chambers. It was found as a general rule that the copra on the floor did not dry at all well, while that on the partition dried unevenly. Under these conditions it was very difficult to get a uniform product or to secure satisfactory drying of a whole charge. This state of affairs was remedied in July when a further 100 trays were received, making 130 in all and thus enabling a maximum charge of 3,900 pounds of green copra at a time to be dried. The balance of trays required will be constructed locally of hardwood and woven wire in order to enable comparison to be made between this type of tray and those of all metal construction.

24. It has been found that much depends on regular firing and upon the quality of the fuel. Wet softwood and husks have invariably made it difficult to dry the copra satisfactorily while with dry hardwood and dry husks a well-dried uniform product has been obtained without difficulty. In the early stages while the firemen were gaining experience and various methods of control were being tested, results varied considerably as will be seen from a perusal of Table II, where selected examples are given.

25. During the first four months the out-turn showed a gradual monthly increase. In July the quantity of copra supplied was comparatively small because the people were engaged in food planting and other communal duties. It will be convenient to quote quantities dried in pounds and to make a monthly comparison in the form of a table.

TABLE I.

Month.	No. of charges.	Weight of copra.		Average per charge.		Mean loss in weight on drying.
		Wet.	Dried.	Wet.	Dry.	
		lb	lb	lb	lb	Per cent.
March	18	29,930	18,100	1,663	1,006	39·5
April	21	39,681	22,818	1,890	1,087	42·4
May	22	49,913	28,886	2,269	1,313	42·1
June	22	57,155	34,018	2,598	1,546	40·5
July	11	16,877	9,563	1,534	869	43·3
August	11	35,079	20,774	3,189	1,888	40·7
Total ..	105	228,635	134,159	2,177	1,278	41·3

26. It is significant that the average weight of copra per charge in March was 1,663 pounds, while in August it was 3,189 pounds, practically twice as much. During the first month weather conditions in many cases were adverse and combined with the inexperience of those operating the drier led to insufficient drying during the 22 or 23 hours normal working period. In April a considerable improvement was evident which was well maintained during later months. The arrival of the additional trays marked the beginning of a period of uniformly satisfactory drying.

27. Mention has already been made of the suitability of the drier for continuous operation, but in accordance with the Fijian custom of strict observance of the Sabbath, little or no firing is usually done on Sunday, with the result that the drier has to be started up practically from the cold on Monday morning. It has been found that the whole installation takes some hours to heat up and except when it is necessary to close down for inspection and over-haul it is hoped to be able to make arrangements to secure better continuity and to avoid such difficulties.

28. The drying chamber is very sensitive to wind. The prevailing wind blows directly on to the end wall of No. 1 compartment and has on several occasions given rise to considerable difficulty in maintaining this compartment at the proper temperature. The loss of heat from the asbestos-cement walls was commented upon in paragraph 17. The remedy of complete insulation of the drying chamber with Insulex and Gyproc will be completed as soon as possible and it is confidently expected that this will increase the efficiency and reduce the fuel consumption of the drier. It is also evident

that the drier should be housed in a building of adequate size to enable loading and unloading operations to be conducted entirely under cover, and to minimise loss of heat now caused occasionally by strong winds and driving rain.

29. Careful temperature records of different portions of the drying chambers have been kept throughout and have enabled a system of damper control suited to this particular installation to be introduced. A distance recording thermograph and hygrograph has also been installed. The thermometer bulbs are situated above the central partition in No. 4 chamber in the middle of the chamber, while the instrument is mounted on the roof where it is readily accessible both for observation and for changing of the records. A timetable of observation is kept in which are recorded temperatures, position of control openings, and other data relative to the charge being dealt with. The observations in Table II are taken from the records. Experimental work is being continued with the drier, and it is hoped to issue further reports from time to time.

30. It may be of interest to record that the cost of the drier erected and equipped with 130 trays, exclusive of the shed, was £455.

TABLE II.

No.	Date.	Charge.	Dry copra.	Loss in weight (moisture driven off).	Condition of dry copra.	Remarks.
		lb	lb	Per cent.		
1	11/3/32	1,258	787	37·4	Unevenly dried. Slight scorching on upper and lower trays.	24 hours drying.
2	12/3/32	1,308	753	42·5	Thoroughly dry copra of good colour and quality.	38 hours drying. Small fire during Sunday. Copra discharged at 6.0 a.m. Monday.
3	16/3/32	1,685	959	43·1	Well dried except for floor of No. 6.	All chambers used, 5 trays to each. Copra on floors and partitions.
4	23/3/32	2,015	1,165	42·1	Well dried throughout.	Similar loading to 3; 32 lb per tray. One sack of copra on each floor and partition.
5	31/3/32	1,592	939	41·0	Good.	33 hours drying. Charge and fuel very wet. Temperatures uniform.
6	5/4/32	1,832	1,155	36·9	Badly dried.	Strong wind and heavy rain beating against walls of drying chamber.
7	11/4/32	1,545	917	40·6	Generally good. Copra on floors and partitions not quite dried.	Monday. Drier slow in heating up; 23 hours drying.
8	13/4/32	2,250	1,301	42·1	A good drying. Slight local scorching at lower end of chamber.	Careful control gave more even heat distribution; 22 hours drying.
9	15/4/32	1,778	1,010	43·2	Good. Slight local scorching.	25 trays in No. 1 compartment. Other compartments loaded on partitions and floors.
10	18/4/32	2,310	1,310	43·2	Trays well dried, no scorching. Copra on floors not dry.	Loading as 9; 30 hours slow drying. Concluded floors useless unless great heat applied which causes local scorching in other parts.
11	25/4/32	1,720	952	44·6	Good. Slight local scorching.	22 hours drying. Fijian fireman without supervision.
12	6/5/32	2,014	1,154	42·7	Well dried, except copra on floor of No. 4.	Compartments 1 and 6 under test with equal loadings; copra also in other compartments. With hot air dampers full open (12 hours) No. 6 showed slightly higher temperatures than No. 1. In final stages of drying, temperatures were uniform and steady in both; 22 hours drying.
13	9/5/32	2,131	1,241	41·7	Well dried on trays, but not on floors.	
14	10/5/32	2,362	1,342	43·1	All well dried.	
15	11/5/32	2,011	1,112	44·7	Very good, well-dried copra.	
16	15/7/32	2,459	1,309	46·7	Very good, well-dried copra.	Loaded entirely on trays. (Additional supply arrived early July).
17	10/8/32	2,674	1,510	43·5	Well dried, uniform.	130 trays; 20·5 lb per tray; 22 hours.
18	11/8/32	3,420	2,011	41·1	Good.	22 hours.
19	12/8/32	3,815	2,204	42·2	Well dried.	30 lb per tray; 22 hours.
20	19/8/32	3,388	1,929	43·1	Very good, well-dried copra.	26 lb per tray; good fuel; 22 hours.
21	22/8/32	3,478	2,058	40·8	Generally good. Outer tray of lowest line in each compartment not quite dry.	22 hours; "green" fuel.
22	30/8/32	3,793	2,100	44·6	Very good, thoroughly dry copra.	29 lb per tray; 22 hours.

CONTENTS.